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THE MANUFACTURE OF STEEL BALLS

MAKING THE BLANKS

By ROBERT H. GRANT*

Robert H. Grant†

A REVIEW of the history of ball-making would take us back, it is claimed, more than four thousand years. The Chinese, who seem to have made everything first, are supposed to have made balls at that early date. This claim, however, is founded on a mere assumption and not on historical fact. Modern ball-making dates back to about 1870. Bicycles were then used to some extent in England, but as the bicycle was first made with a plain bearing, it was very laborious to propel; later cone bearings were introduced, and while these made the bicycle easier to work, it never became very popular until balls were used in the bearings. The first balls were made by the English workmen in their own homes, as was the custom in those days, by a very primitive method. A bar of steel of the proper size was placed in a chuck in a foot-power lathe. Then a ball was formed on the end of the bar by means of a hand tool, the long handle of which was pressed against the shoulder. The balls were made only a few thousandths of an inch larger than the finished size. They were then hardened and ground. The grinding was done between two cast-iron plates about eighteen inches in diameter. These plates were provided with concentric circular grooves, and the balls were placed in these grooves with oil and emery. The top plate was then revolved by hand; it was removed at intervals and the balls measured until found to be of the proper size. These balls were sold for 12 cents apiece. At the present time balls of the same size, and of a superior quality, can be purchased for 1/7 cent.

First Machines for Manufacturing Balls

The Simonds Rolling Machine Co., of Fitchburg, Mass., was the first company in the United States to engage in the manufacture of balls. This company was manufacturing a machine for making rolled forgings, and as by means of this machine it was possible to roll a very accurate ball, it was decided to start the manufacture of this product. In Fig. 1 is shown a 3-inch rolling machine of the type mentioned, the size (3-inch) indicating the width of the platens. These platens run in opposite directions, and are operated by racks in the back, which, in turn, are driven by pinions on the driving shaft. The driving shaft extends to the rear of the machine where the driving gears are located. The length of the stroke is changed by the dogs *A*, which can be moved to different positions in a grooved plate, as shown. The rest *B* supports the stock while it is being rolled. The platens make about one-hundred strokes per minute.

In Fig. 2 is shown a die for rolling balls on the Simonds machine. This die is held in a shoe which is fastened to the

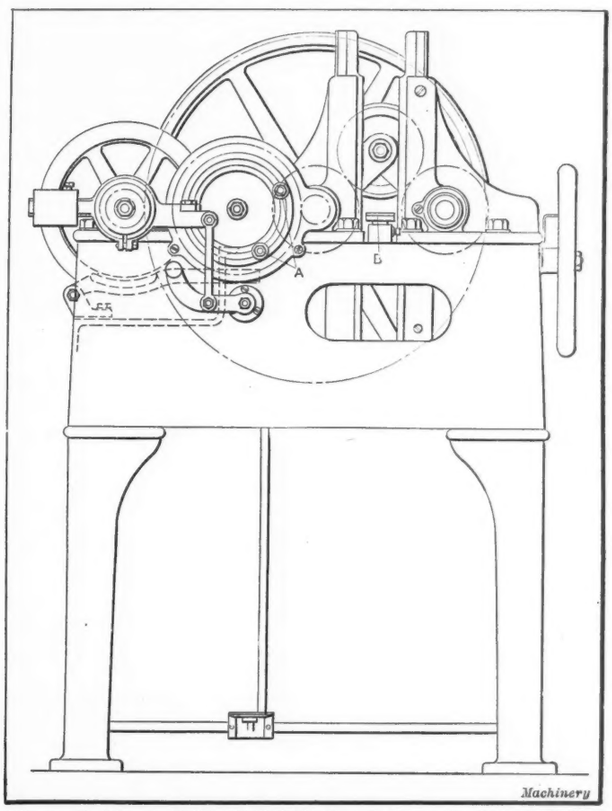

Fig. 1. Machine for Making Rolled Forgings, built by the Simonds Rolling Machine Co., Fitchburg, Mass., Some Twenty-five Years ago

platen. The 30-degree beveled face on the die is knurled so that when the work is rolled, it will not slide through the dies, but rotate properly. The knurling of the beveled face of the dies was one of the most important of the patents obtained by the company in connection with this development. The "invention," however, was incidental. During the early stage of the development of the machine, a workman had been trying to roll a certain piece, but the stock would keep sliding through the machine without rolling. The operator then lost patience and, determined to make the stock roll, took a cold chisel and roughed up the edges of the die, with the result that the die immediately produced perfect forgings. On the next set of dies made, he used a coarse knurl on the edges of the die to facilitate the proper movement of the stock. This method of knurling was patented in connection with the

* Address: 912 Oakland Ave., Ann Arbor, Mich.

† Robert H. Grant is a graduate of the Fitchburg High School and the Fairchild Institute of Flushing, N. Y. His mechanical training was obtained with the Pratt & Whitney Co., Hartford, Conn., and with the Simonds Rolling Machine Co., Fitchburg, Mass., where his father, John J. Grant, who built and equipped the first ball factory in America, was superintendent. With his father, Mr. Grant organized the Grant Anti-Friction Ball Co., which was later consolidated with the Cleveland Machine Screw Co., of Cleveland, O. This company was very successful and was sold for a large sum to a French syndicate. Mr. Grant then organized the Grant Ball Co., of Cleveland, O., which manufactured balls and screw machine products. This company was also successful, but as Mr. Grant did not have a controlling interest, he sold his stock to a company at Franklin, Pa., and became superintendent of the Standard Roller Bearing Co., of Philadelphia, Pa., which at that time had only a small factory employing fifteen men. Within three years this company acquired control of ninety per cent of the ball trade in this country and had built and equipped a plant covering several acres. After some years the control of this company was acquired by New York capitalists, changes were made in the management, and Mr. Grant severed his connection after having been about eight years with this concern. He is now designing machinery and equipping plants for the manufacture of balls and ball and roller bearings. In the last few years he equipped the Atlas Ball Co., of Philadelphia, Pa., the New Departure Mfg. Co., of Bristol, Conn., and the Flanders Mfg. Co., of Chelsea, Mich. He is now working on a large ball plant for this country and on two plants to be built abroad. In years past he also equipped two foreign plants, the Deutsche Waffen and Munitionsfabriken in Berlin, Germany, and the Clement & Cie, Paris, France, both of which concerns have been very successful.

die, and this patent was considered one of the strongest in connection with rolling processes of this kind.

The method of rolling balls, however, is very wasteful on account of the fact that the stock which revolves over the knurled part of the die is thrown away as scrap. For every ball that is made, a diamond-shaped piece, as shown in Fig. 3, of the same diameter as the stock, has to be made and thrown away. In the illustration referred to, *A* is the stock, *B* is the ball being rolled, and *C* the diamond-shaped piece which is wasted. Hence, it will be understood that this method is very expensive when used for ball-making, although the rolling method of forging can be used to advantage on long articles where the waste is proportionately small.

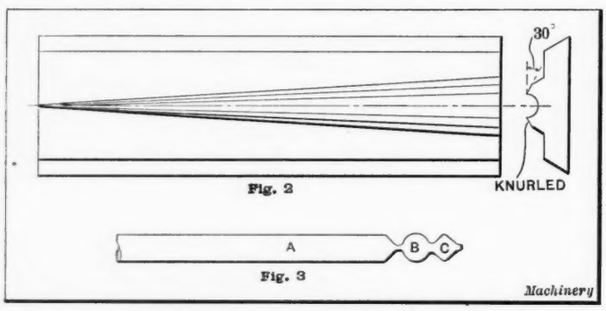

Fig. 2. Die for 3/8-inch Ball, used on Machine shown in Fig. 1. Fig. 3. Ball and Scrap resulting from Rolling Balls

In rolling methods of this kind there is a decided tendency to "pipe" the stock on account of the difference between the speed at the largest diameter and that at the "centers" of the ball, where, as a matter of fact, the metal is simply crushed and does not roll. Frequently there will then be a hole or pipe right through the center of the ball which will show after the teats at the end have been ground off. As an example of the tendency to pipe, it may be mentioned that once in the writer's experience some spindles 12 inches long and 5/16 inch in diameter were rolled with pipes right through so that a string could be put through the center. For this and other reasons, although the Simonds machine was most interesting from a mechanical point of view, it had comparatively little value commercially.

Several other ball companies had no good blanking process, and, therefore, hired men who understood the rolling process from the Simonds Co. A number of machines were thus designed similar to the Simonds type. One of these had circular platens instead of straight ones, and was made with circular dies, one within the other. The die holders, of course, were running in opposite directions. This machine worked satisfactorily, but the dies were much more difficult to make on account of their circular shape, and also on account of the fact that the inner die was smaller than the outer. The company designing this machine did not have a good grinding process and the machine was, therefore, soon abandoned on account of discontinuing the manufacture of balls.

Another rolling machine constructed on the same principle was made with platens of circular form running horizontally instead of vertically. The dies were circular, but of the same diameter, and were placed on the platen near the outer periphery. There were four dies in all to take up the circumference. The platens were run in opposite directions to each other. This machine was very rapid in its action and continuous in its operation, as the dies always ran in one direction and did not have to reverse. Another rolling machine was made with two small circular disks with the dies cut in the periphery. These disks were keyed to spindles which were geared together and were made to run in opposite directions. This machine worked satisfactorily on small balls, and is still used by some of the smaller ball manufacturing firms.

A number of machines have been designed from time to time for the making of ball blanks; some of these have been rather ingenious although many of them have not been successful. In Fig. 4 is shown a machine invented by Mr. M. F. Christensen, of Cleveland, O. The slugs or blanks *H* are fed in at the upper end of a cone-shaped device. The cone *F* revolves, being driven from pulley *K*. The inner face of the casing *G* is provided with a spiral groove from top to bottom, the section of the groove being more and more that of a complete circle as it approaches the bottom of the cone. The blank, as it runs around the cone, is supposed to be gradually rounded as it approaches the bottom. The machine, however, never proved successful for several reasons. The distance that the slugs or blanks had to travel proved a disadvantage, because if the slugs were heated, they became cold before they had passed through the device and would not compress, but were simply split open; if the slugs were not heated, the grain of the material was so distorted or crystallized that the balls could not be used. Again, if the slugs did not roll, but commenced to slide, causing clogging, the machine would have to be entirely dismantled in order to locate the trouble. Hence, after long and extensive experiments, it was abandoned.

Machines for Turning Ball Blanks

On account of the piping and burning of the steel and the difficulty of removing the teats from the balls, the manufacturers next took up the turning process for making ball blanks. The first successful machine invented was designed by the writer and is shown in Fig. 5. This machine is an automatic ball turning machine with a regular draw-back collet and automatic feed for the stock. The special feature of the machine is the manner of forming the ball. There is no turret slide or feed mechanism, but simply a solid tailstock with a heavy faceplate having a cam cut in the face, as indicated in the views at *B* and *C*. This cam is driven from cone pulley *E* through gears *H*, *J* and *K*. On the tailstock a plate with three jaws *D*, *F* and *G* is fastened, each of these jaws holding a forming tool and being provided with a roller which fits into the cam groove in the faceplate. When the ma-

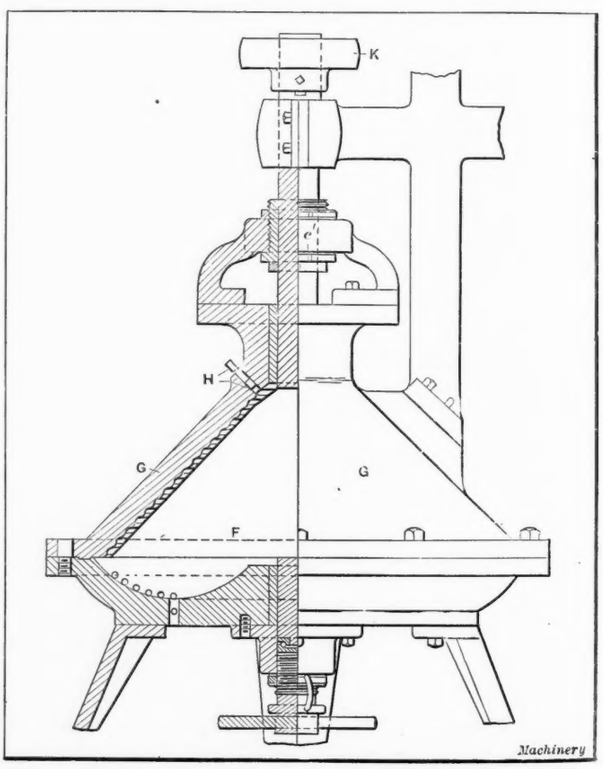

Fig. 4. The Christensen Ball Rolling Machine—U. S. Patent No. 632,336

chine is in operation, each jaw with its forming tool comes forward and does its share of the work (as indicated at *L*, *M* and *N*), and is then moved back to allow the next jaw to come into action. The last or third jaw cuts off the ball and rounds the end of the stock so that there will be a proper surface on which to start the cut for the next ball. Another form of turning machine was provided with a head similar to a regular plain automatic machine, having for toolholders rocker arms operated upon by a shaft at the rear of the machine. The shaft allows the arms to descend onto the stock to form the ball and then moves them back while the cutting-off tool performs its work.

The latest machine for ball turning is the Hoffmann ma-

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chine shown in Fig. 6. This machine has two heads exactly alike, one at each end of the bed, these heads having regular automatic screw machine spindles. The slide in the middle of the bed is made very heavy because of being double and carrying two sets of forming tools. Four balls are formed at a time. The first ball from the stock end is about one-half finished, the second one, three-fourths finished, and the third one, completed, while the fourth ball is held in the second spindle, which is revolving at exactly the same speed as the first. This allows the forming tool to round the end of the ball so that it will be an accurate sphere. The ball is then fed on through the second spindle and drops into a pan. On account of

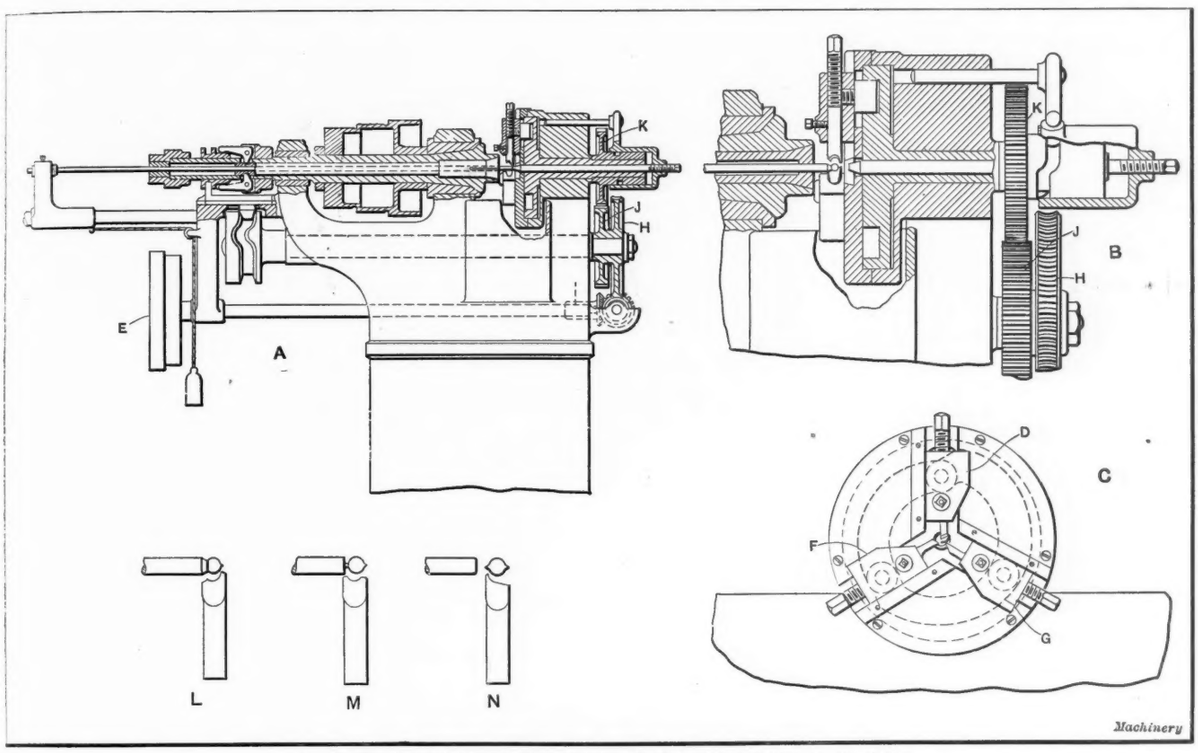

Fig. 5. The Grant Automatic Ball Turning Machine—U. S. Patent No. 517,004

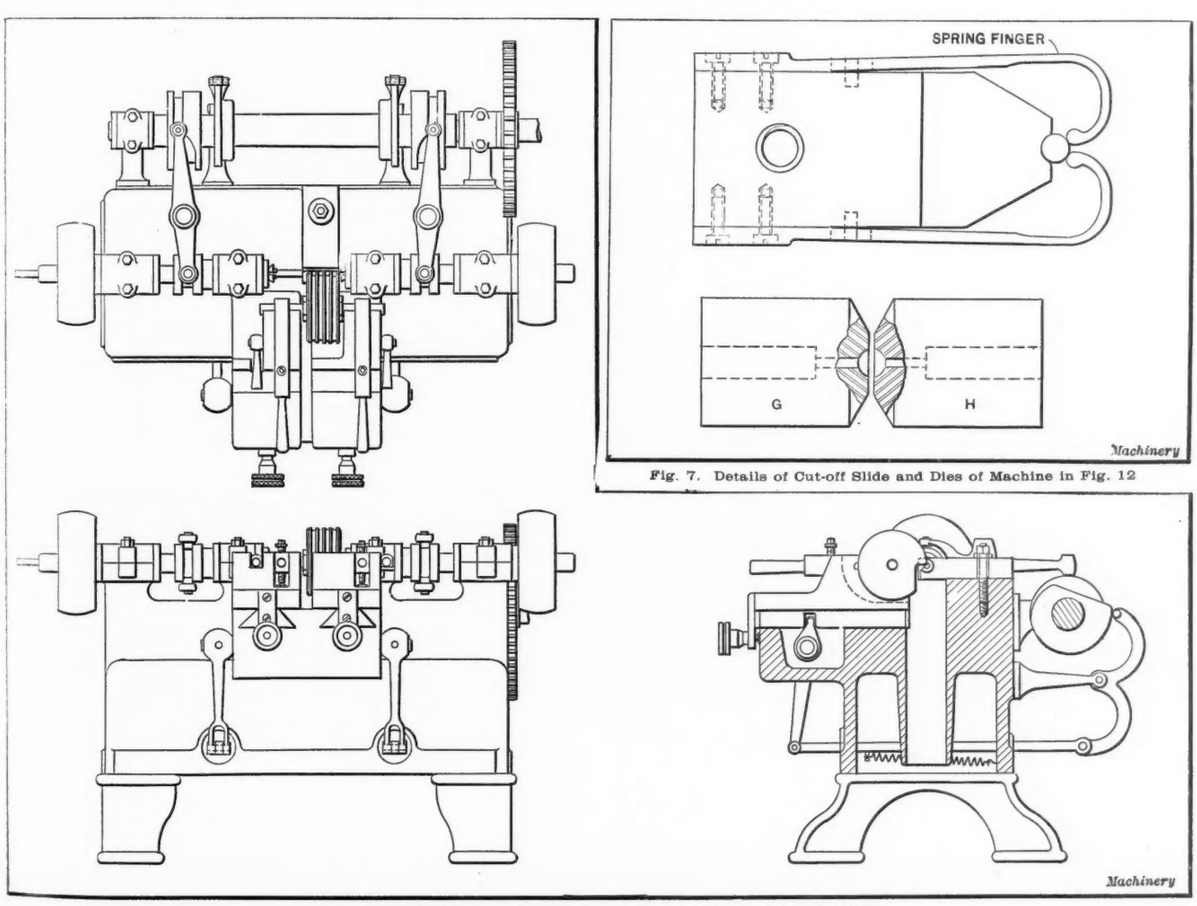

Fig. 7. Details of Cut-off Slide and Dies of Machine in Fig. 12

Fig. 6. The Hoffmann Ball Turning Machine—U. S. Patent No. 624,488

forming four balls at a time, a roller rest is used in the rear of the slide. This rest has two rollers made of hardened steel against which the stock revolves while the forming is being done. This allows the forming tool to form a perfect ball, as the stock cannot recede while the tools are at work. This is a feature of considerable value when balls are turned from tool-steel rods which it is impossible to fully anneal.

When turning balls by the method described, the stock wasted is greater than that which goes into the ball. The method is, therefore, used very little for balls over one-fourth inch in diameter, because the price of the steel becomes an important factor in the cost of manufacture when larger sizes are made. Another disadvantage is that balls cut from the bar are not as strong as when made by other methods. The direction of the grains or fibers of the steel wire is lengthwise of the bar; therefore, when the ball is formed, these fibers are cut and exposed at the surface, making a ball which is inferior in strength after hardening to balls made by other methods.

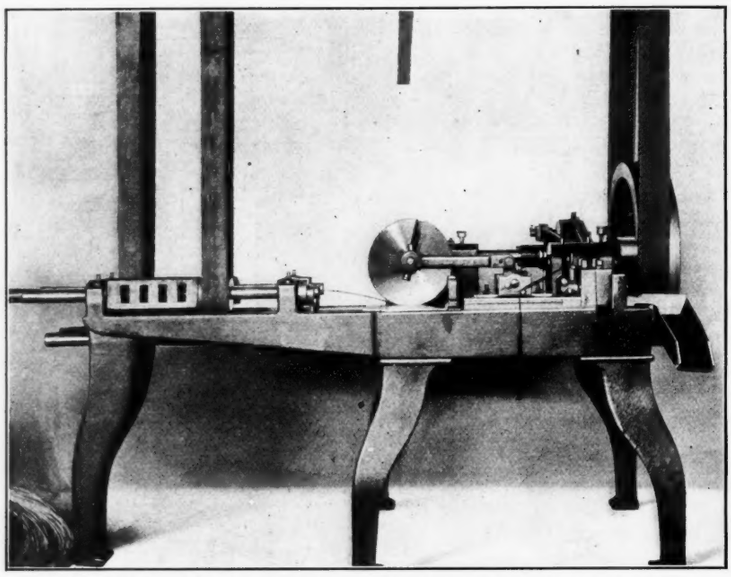

Fig. 8. Wire Straightening and Cutting-off Machine used for Cutting-off the Slugs for Pressing into Balls

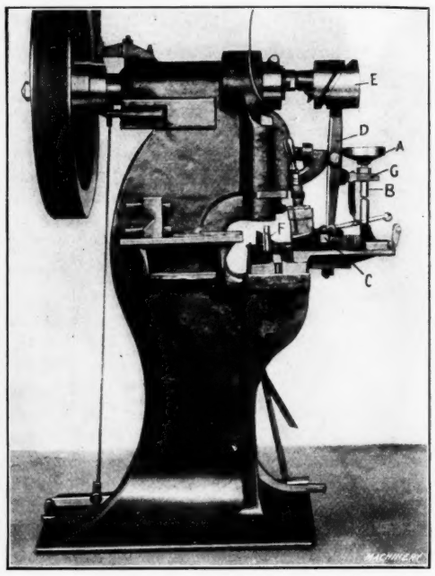

Fig. 9. Ferracute Press with Automatic Attachment for Pressing Balls

Pressing Balls

About fifteen years ago when the bicycle business was booming, the Cleveland Machine Screw Co., which was at that time one of the largest of the firms in the country manufacturing balls, was unable to make enough blanks by the turning process, so it developed a process of pressing the ball blanks. In Fig. 8 is shown a regular wire straightener and cutting-off machine by which a coil of wire was straightened and then cut into short lengths called "slugs." This cutting-off must be very carefully done as otherwise the ball made from the slug will be of poor quality, because of the ends or ragged parts being pressed into the ball and forming a cold shut. This may fall out during the grinding or hardening operations, the ball then having a pitted appearance. The length of the slugs

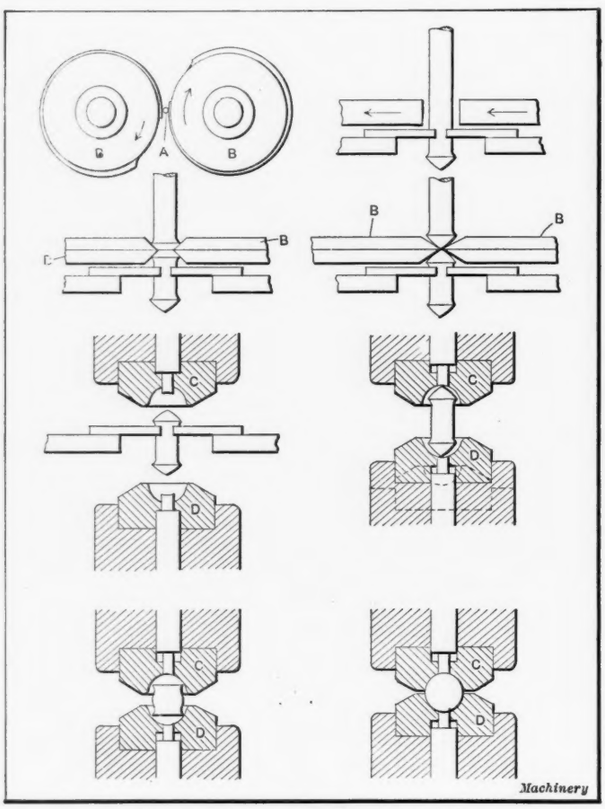

Fig. 10. Diagrammatical Views of the Various Stages of the Reid Process

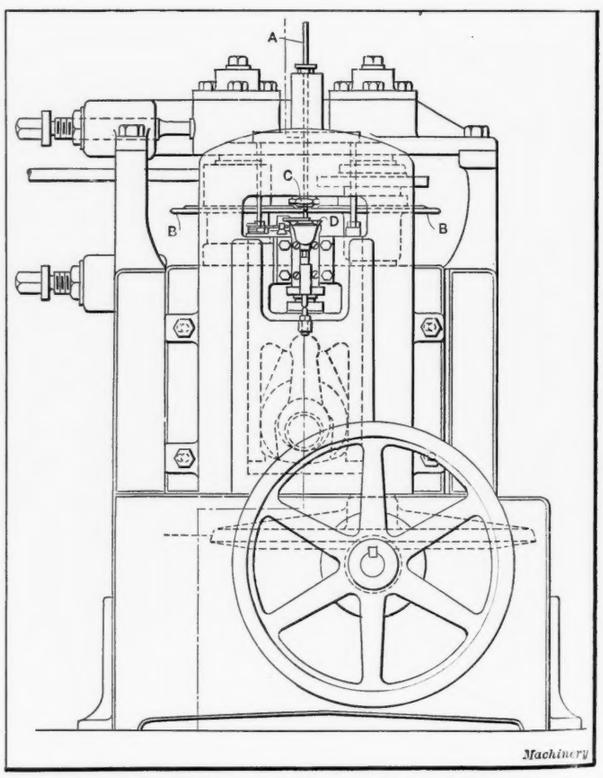

Fig. 11. The Reid Machine for Making Slugs with Tapered Ends and Pressing Balls—U. S. Patent No. 801,267

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also must be exact, otherwise the blanks will be badly out of shape. If the slugs are not square on the ends when placed in the die, they will crowd to one side, a lopsided ball being the result.

In Fig. 9 is shown a regular No. 2 Ferracute press with an automatic attachment for pressing balls. This attachment is entirely automatic in its action, the slugs being fed down

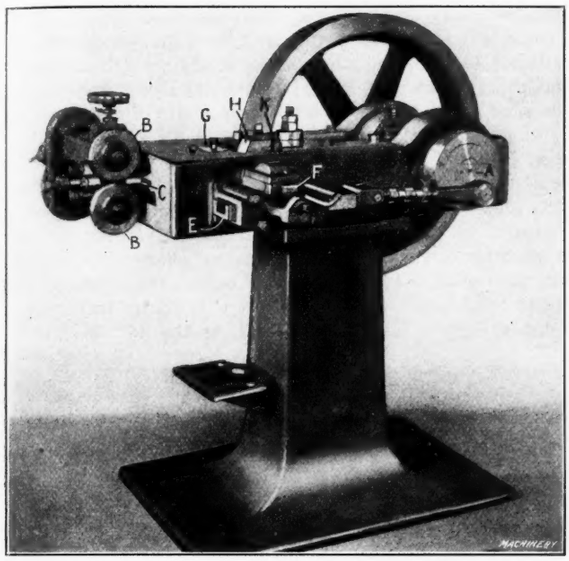

Fig. 12. The E. J. Manville Machine Co.'s Rivet Header arranged for Making Balls

from the hopper and then conveyed by an arm to the die where the ball is pressed, after which the latter is ejected by the knock-out. At *A* is shown the hopper which holds the slugs, and at *G*, a fork which works the hopper up and down, keeping the slugs falling into the tube *B*. Fork *G* is operated through the lever *D* which is given a reciprocating motion by cam *E*. Lever *D* also moves a rack operating pinion *C*, which latter has an arm attached to it that carries the slug from the bottom of tube *B* to the dies in the press proper. The press is so timed that the slug is firmly held between the dies for a moment before the dies come together, thus giving the feeding arm time to pull away. While the pressing is being done, the arm receives another slug from tube *B*. This method of pressing is very cheap and very little material is wasted. On account of the press being of the regular open-front type, however, the blanks can be pressed only a small amount, because otherwise the machine will spring away from the work which is not heated. Hence when larger diameters are pressed, the balls are only approximately spherical, and a large quantity of stock is left for the dry grinders to remove. It has, therefore, not been practical to press balls by this method when they are larger than ⅜ inch in diameter.

The Reid Ball Pressing Machine

Fig. 11 shows a machine designed by Mr. M. Reid for cutting the slugs tapering at both ends, so that when pressing the ball no ragged edge can be pressed into it. The stock *A*, which comes in straight bars, is fed into the machine by gravity. Cutters *B* (shown also in Fig. 10), somewhat similar to pipe cutters, sever the stock and at the same time taper the ends. The stock is then fed to dies *C* and *D* and the ball is formed as indicated by the various illustrations in Fig. 10. As this process is done with heated stock, a very good blank is produced. The sharp edges usually formed when cutting off the stock, are done away with by this method, and only the central part of the ball has to be pressed up, as the tapered ends are simply rounded.

The Manville Machine

The latest and best designed machine for the manufacture of small ball blanks is made by the E. J. Manville Machine Co., Waterbury, Conn. This machine has a coining-press type of frame, except that it is horizontal instead of vertical. All the work is done inside of the frame, so that a very accurate blank can be produced on account of the rigidity thus obtainable. Fig. 12 shows one of the smaller sizes of these machines. This size is used for making balls up to ¼ inch in diameter. The stock which comes in coils is first passed through the straightening rolls *B* and then through tube *C* into the cutting-off die. Slide *E* has a cam which carries the cutting-off device or tool *F*. This cutting-off tool is flat and has spring fingers as indicated in Fig. 7. These fingers overlap the groove at the end of the cut-off tool. After the stock has been cut off, these fingers hold the slug in position on the cut-off tool until the cam in slide *E* carries the tool with the slug over to the center of the dies. Die *G* is stationary and die *H* is mounted in movable slide *K*, which is carried forward by the eccentric on shaft *A*. As soon as the slug has been clamped between

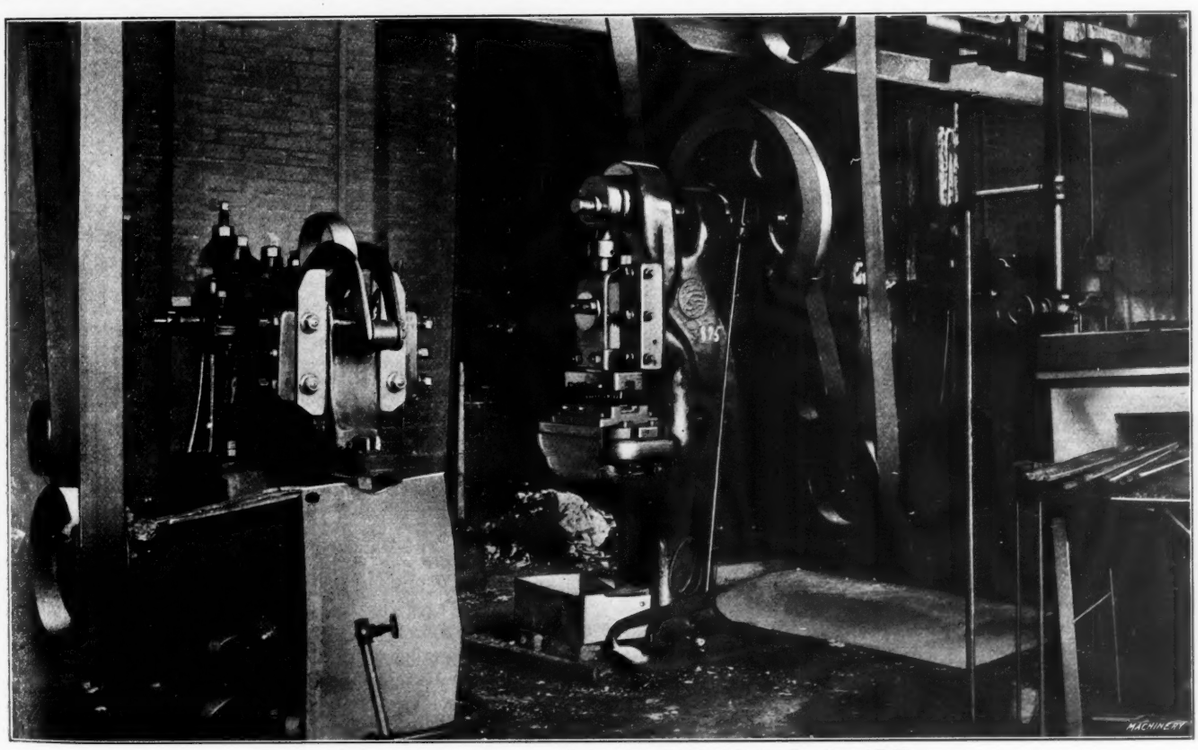

Fig. 13. Upright Helve Hammer and Press, arranged for String Forging of Balls

the two dies, the cut-off *F* moves back and allows the dies *G* and *H* to come together. The dies have holes drilled through them and are counterbored from the back to within one-half inch from the impression in the die. (See Fig. 7.) In these counterbored holes, knock-out pins are placed which are worked by levers on the under side of the machine, so that as soon as the dies draw apart these pins will knock out the ball, no matter which die holds it.

The machine is very rapid in its operation and regular 3/16-inch balls can be made at the rate of 100,000 to 125,000

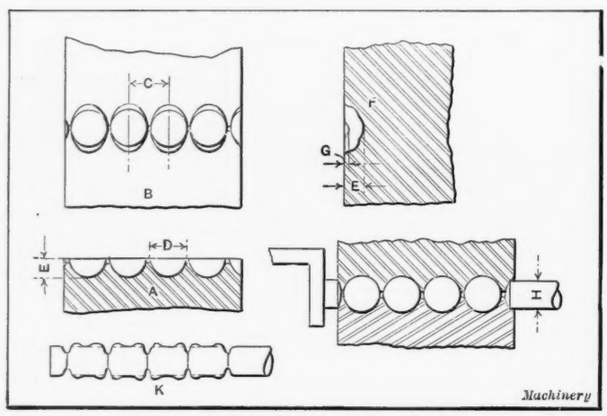

Fig. 14. Details of Dies for String Forging

per day, according to the grade of the stock and the character of the annealing. One man can run three or four of these machines; hence the labor cost is so small as to be almost negligible. As there is no waste, this process, for smaller sizes of balls, must be deemed the best as well as the cheapest in ball manufacture at the present time. The following table gives sizes of stock used for making different sizes of balls:

Diameter of Ball, Inch	Diameter of Stock, Inch	Diameter of Ball, Inch	Diameter of Stock, Inch
1/8	0.095	9/32	0.200
5/32	0.120	5/16	0.225
3/16	0.145	3/8	0.265
7/32	0.165	7/16	0.312
1/4	0.180	1/2	0.355

Ball Forging

The best known method of making ball blanks from 3/8 inch to 2 inches in diameter is known as string forging. Fig. 13

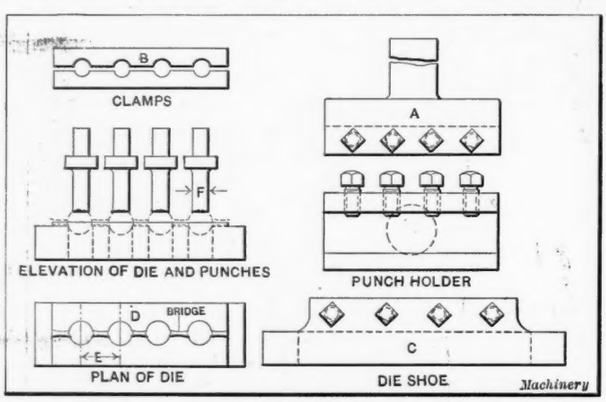

Fig. 15. Tools used for Trimming the Balls after Forging them in a String

shows a regular upright helve hammer and a press, as well as a heating forge, the equipment being arranged for string forging. The bars from which the balls are forged are approximately 6 feet long. Twelve of these bars are put into the furnace at a time and are heated so that two sets of balls can be forged before putting the bar back into the furnace. By having a number of bars in the furnace at the same time, the heating can be done slowly and uniformly, and the bars are heated clear through to the center of the stock without burning or decarbonizing the surface. The forging of the balls requires some skill, as the bar must be turned and the hammer started at high speed, gradually slowing up as the blank begins to assume its proper shape. After being forged, the string of forged balls, indicated at *A* in Fig. 19, is placed in the trimming press where the whole row is forced through a series of holes, thus trimming off the fins and separating the balls into individual blanks. The balls drop directly into a box under the press, as indicated.

Fig. 14 shows by a number of diagrammatical illustrations the manner in which the dies for string forging are made. At *A* is shown a section of a die with four impressions. The illustration also gives the notation of the die details necessary for use in connection with the following table. At *A*, for example, is indicated the diameter *D* of the cutter or cherry used in sinking the die, and also the depth *E* to which the cutter is sunk. In the view at *B* is given the distance *C* between the centers, so selected that when the proper size of stock is used, the die cavity will just be filled. It is also indicated here and at *F* that the die must be backed off or relieved on each side of the impressions, leaving only a small amount of land in the center to do the hammering. This backing off is done by moving the jig around on the milling machine or die sinking machine, and sinking the cutter or cherry into the die about 1/16 inch, leaving the width of the center about one-third of the diameter of the ball. At *G* is shown the depth of the bridge, which is very important, as the neck formed by

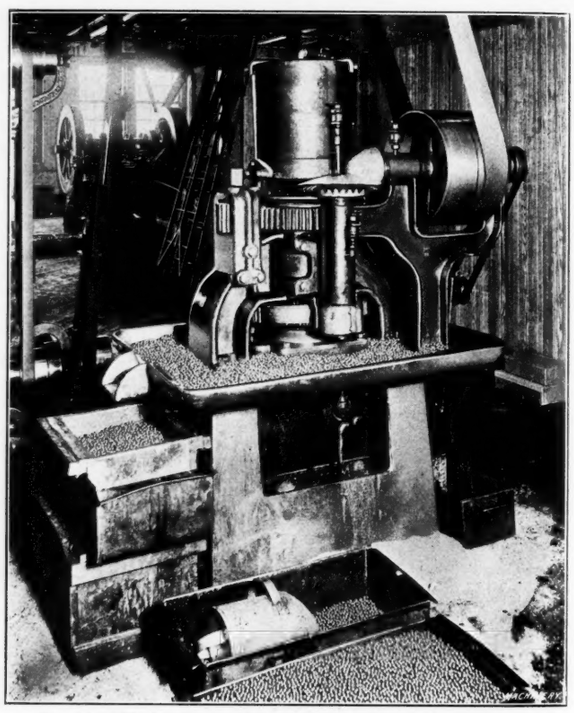

Fig. 16. "Flasher" or Rotary File used for Removing Fins from Forged Balls

the bridge must hold the balls together during the forging and not draw the stock near the neck, so as to cause a pipe, which is very easily done. At *H* is shown the size of the stock which is always smaller than the diameter to be forged. The stock must be close to the required size; otherwise difficulties will be met with. If under size, the balls will not fill out; if too large, extra hammering will be required, which causes the dies to soon wear out. In Fig. 14, four balls are shown forged at a time, but as this illustration is only diagrammatical, it is not implied that this is the correct number used in practice. The following table gives the number of balls that would be forged in a string for different sizes of balls, together with other dimensions required for the sinking of dies. At *K* is shown the stock after it has been slightly hammered to see if the dies are in perfect alignment. It is easily seen that when there are so many impressions in the dies, if the die warps in the hardening, the two dies will not match perfectly, and the balls at either end may be rather poor in quality. It is, therefore, very important to use a die steel that will hold its shape after hardening.

The necessary tools for the trimming of the balls are shown in Fig. 15. At *A* is shown the holder for the punches, the shank fitting into the head of the press. At *B* is shown a

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plate with holes drilled to the same diameter as the shanks of the punches. This plate is sawed in two, and after the punches are placed in the holes, it is clamped in holder *A* and held in place by four set-screws. The diameter *F* of the punches is about one-eighth inch less than the diameter of the balls. At *C* is shown a bolster fastened to the press and at *D* a plan of the die that is drilled with the same distance *E* between the centers of the holes as the distance between the forged balls. A groove is provided between the holes drilled in the bottom die *D* so that the necks between the balls will not touch the top of the die. Die *D* is placed in bolster *C* and lined up with the punches as in ordinary stamping processes.

DATA FOR STRING FORGING OF BALLS

(See Fig. 14 for notation)

Size of Balls	Size of Stock, H	Diam. of Cutter, D	Distance Between Centers, C	Depth of Cavity, E	Depth of Bridge, G	No. of Balls
3/8	0.320	0.395	0.485	0.198	0.040	18
7/16	0.375	0.457	0.550	0.228	0.050	16
1/2	0.437	0.520	0.615	0.260	0.050	14
5/8	33/64	0.645	0.755	0.322	0.060	12
3/4	39/64	0.775	0.910	0.387	0.065	9
7/8	23/32	0.905	1.060	0.452	0.065	8
1	13/16	1.035	1.210	0.517	0.075	7

Furnace used for Heating the Bars

The furnace used for heating the stock is of a special oil burning type. The burner is placed on the side of the furnace midway between the front and the rear. By having a special form of baffle plate directly in front of the flame, the latter is distributed throughout the furnace before it comes out at the front. An air pipe is passed under the opening through which the stock is put in to be heated. This pipe has a number of small holes drilled in the side facing the opening, and when air is forced through these holes, the heat is diverted upward and kept away from the operator.

Large balls, from 2½ inches up, are usually forged under a steam hammer. Stock of the proper diameter is first cut off to the required length and both ends are chamfered. The length of the stock is determined by the weight of the finished ball, an allowance for finishing being added. The blanks are placed in an oil furnace and allowed to heat slowly. Each time a blank is forged, a new one is put into its place in the furnace. The dies for this kind of forging are of an entirely different form from those used for string forging. They are cupped out to the desired diameter, but are only sunk to a depth of one-quarter of the diameter of the ball to be forged, and are not backed off. When the blank is heated, the hammer man places it in the die, and the hammer is worked very slowly until the ball begins to take a spherical shape, at which time quicker and heavier blows

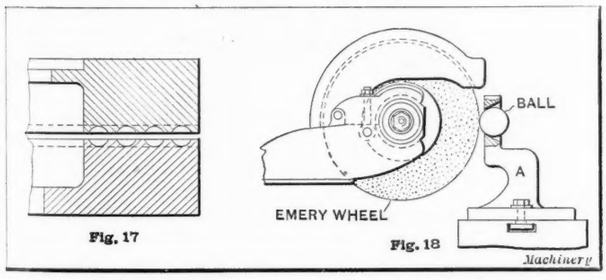

Fig. 17. Principle of Multiple Ring Grinder

Fig. 18. Method of Flashing Large Balls

are struck. On account of the impressions in the dies being so shallow, the operator has ample space to turn the ball in all directions, and can, therefore, produce an almost true sphere. Blanks 4 inches in diameter have been forged that have not been out of round over 0.005 or 0.006 inch.

The Flashing Process

The ball blanks as they come from the press or hammer are more or less out of shape and have a flash or fin or some other projection caused by the cutting-off or the wearing of the dies. These fins must be removed before the first grinding as they would otherwise mar the grinding rings. In Fig. 16 is shown what is known as a rotary file or flasher used for removing these fins. The balls are fed through the spindle by gravity and discharged from the rotary filing plates by centrifugal action. The head of the machine, which is run by a worm and worm-wheel, has a spindle to the end of which the rotary file is attached. As the spindle is hollow, the balls can be fed through it to the center of the plate. The lower plate is solid, but is adjustable up and down, allowing for different sizes of balls and for wear. The balls as they pass from the spindle to the center of the plate, are filed by the upper plate revolving and forcing them over the lower, and they fall out at the outer edge into a basket. The operation is repeated after the lower plate has been adjusted. The plates are kept from clogging by a mixture of lard and kerosene oil, circulated by a pump from a tank below to a reservoir above.

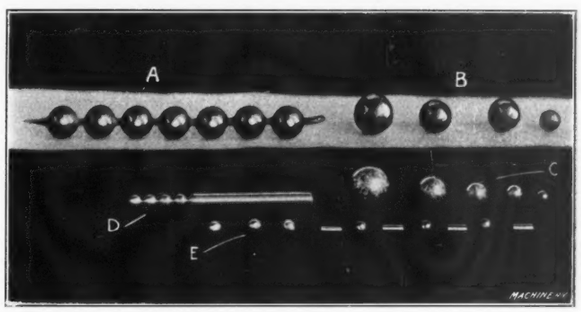

Fig. 19. Sample of Balls made by Various Processes at Different Stages of Completion

There is also another method of removing the flash or fin from the balls, known as the multiple ring grinding process. Fig. 17 shows a diagrammatical sketch of the principle of this method. Rings which are slightly grooved are placed on a heavy grinder similar to a drill press. The grooves are filled with balls and No. 36 emery or carborundum. The top ring is fastened to the spindle and allowed to revolve at a high speed while pressure is being applied. In a short time the balls are removed and found to be comparatively smooth and ready for the first dry grinding.

The larger balls are ground separately in a very simple but effective way, as indicated in Fig. 18. An upright *A* is bolted to the table of a small emery wheel grinder. This upright has a tapered hole through it into which the ball is pushed and adjusted so that the ball after the flash has been removed will barely touch the emery wheel. The operator, by means of a short pair of tongs, can turn the ball in all directions. As the ball cannot pass through the tapered hole in the upright more than a certain distance, flat spots cannot be ground, but the fin is simply removed and a smooth surface produced.

In Fig. 19 are shown a number of samples of balls made by various processes and at different stages of completion. At *A* is shown a string of forged balls, and at *B* forged balls after trimming. At *C* are shown a number of balls after being rough ground, at *D* the end of a bar operated upon in a Hoffmann ball turning machine, and at *E* a number of slugs and balls pressed from them.

Kind of Steel used in Ball-making

The most important thing to be considered in the manufacture of balls is the quality of steel used. One of the largest elevator companies in the United States tried 432 different samples of steel, obtained in this country and abroad. Balls from these samples were made and tested by being put into actual use. From these tests it was ascertained that the two grades of steel below (carbon and alloy) are best suited for making steel balls.

1.—Carbon, 1.12; silicon, 0.015; phosphorus, 0.017; manganese, 0.19; sulphur, 0.019; chromium, 0.25 per cent.

2.—Carbon, 0.95; silicon, 0.014; sulphur, 0.019; phosphorus, 0.018; manganese, 0.025; chromium, 1.25; tungsten, 0.25 per cent.

In the articles to follow the writer will take up the subject of rough grinding, hardening and finish grinding of steel balls, and also the inspection, grading and testing of balls, together with a review of the use of steel balls, and hints for purchasers regarding the quality of balls.

TOOLS FOR FOUR-SLIDE AUTOMATIC WIRE-FORMING MACHINE

By CHESTER L. LUCAS*

At the factory of the Baird Machine Co., Bridgeport, Conn., the standard automatic wire-forming machines made by the company are "tooled up" for producing many interesting products of wire-forming. It is the purpose of this article to illustrate the important features of four-slide automatic wire-forming machinery, and to describe a few sets of wire-forming tools made in this factory and elsewhere.

Four-slide automatic wire-forming machines are made by many different companies, and although each make has some

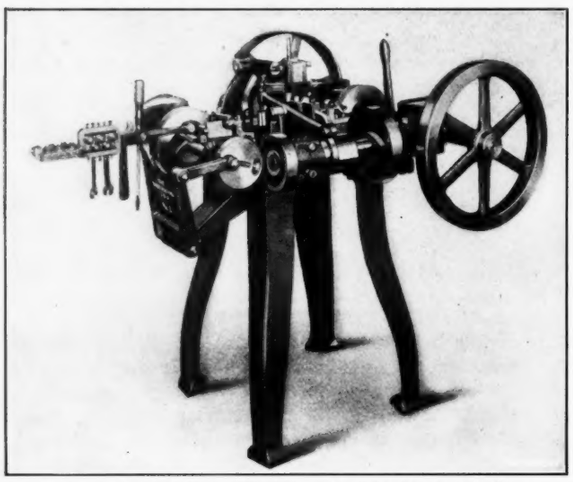

Fig. 1. A Typical Four-slide Automatic Wire-forming Machine

special features of its own, the underlying principles are the same. The Baird four-slide automatic wire-forming machine furnishes a good representative machine of this type. The general appearance of the machine is shown in Fig. 1, and its important working parts, such as the straightener *A*, the feed *B*, the cut-off *C*, the grip, the form-holder *D*, the stripper, slides and dies are illustrated in the plan view of the machine in Fig. 2.

Straightener, Feed, Cut-off and Grip

The wire enters the machine at the straightener *A* indicated in Fig. 2. The object of the straightener is to take out kinks in the wire, so that it may go to the forming tools in good condition. The straightener consists of two sets of rolls, set at right angles to each other. These rolls are not located opposite each other, but are staggered. By means of set-screws, individual adjustment is available for each roll so that spring wire may be just as effectually straightened as soft copper wire.

The forward feeding of the wire is accomplished by a crank, best shown in Fig. 3, where *A* is a pin adjustable on the crank-plate by means of nut *B*. The adjustment permits any desired stroke to be given to feed-slide *C*, which feeds the wire forward at each revolution of the crank-plate. The gripping finger *D* is hinged so that at the beginning of the forward movement of slide *C* this finger grips the wire, pulling it through the straightener and forward with the slide. As soon as the return stroke commences, the wire is released, and the slide and gripping finger return to the starting position.

The cut-off, shown in detail in Fig. 4, is operated from the front of the machine. It consists of a slide *E*, whose end roller bears against a cam *F* on one of the four main cam-shafts. The cut-off is adjustable for different lengths of wire by means of an adjusting screw *G* terminating in a small pinion which, in turn, engages a rack *H*. The cut-off is held in position by means of the clamping bolt *I*, located beside the adjusting screw.

When the wire has been fed forward the proper distance, the gripping finger releases its hold upon the wire and starts on the return stroke. At this point the tension in the wire would cause it to relax slightly, especially in the case of spring wire, making it impossible to cut it to exact lengths. To overcome this trouble, a grip is provided that holds the wire during the time it is not being fed by the gripping finger. This grip, shown in Fig. 3, is at one end of an arm *J*, that is pivoted in the center. The other end of this arm is fitted with a roll *K* bearing upon a cam *L* on one of the main shafts of the machine, thus giving the grip a downward pressure on the wire at *M*, and releasing it at the instant the forward feed starts.

Form-holder and Stripper

The forming of most wire pieces necessitates the use of a center form or arbor, about which the wire is bent. This form is sometimes called the center die. The standard size for the body of the center form is 1¼ inch by 1½ inch. To support this form, a cast-iron form-holding bracket, shown in Fig. 5, is provided at the center of the machine. This bracket will accommodate either the rigid form or the swinging type of form, as desired.

For releasing the wire article from the form, after it has been bent, a stripper is provided. The stripper rod passes through the form and upon its lower end the stripping plates are held. These stripping plates are made of sheet iron from 1/16 to 1/8 inch thick. The stripper rod is reciprocated by an independent arm, in a manner similar to that in which the grip is operated.

The Forming Slides

The forming slides that operate from the four sides of the machine are the most important features of the machine, and it is from these slides that the machine derives its name. The slides are reciprocated by the cams on the four main shafts. Both cams and cam-rolls are faced with hardened steel to withstand wear. The forming tools or dies are bolted to the forward ends of these slides, and adjustment is provided for by means of set-screws bearing against the ends of the dies.

The cams that impart the reciprocating movement to the

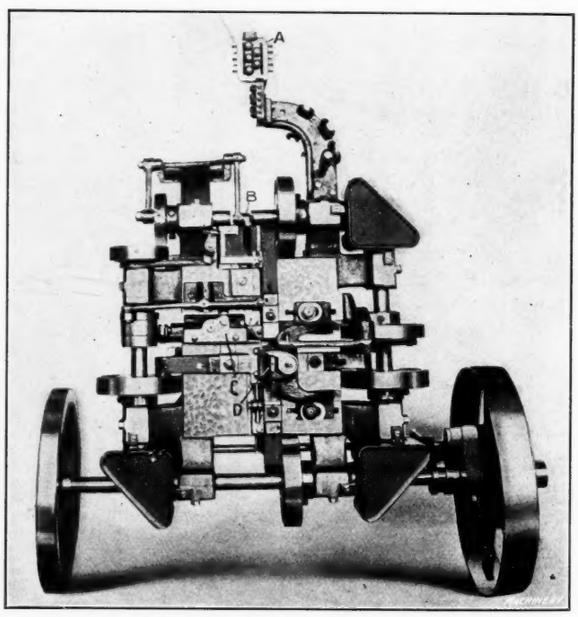

Fig. 2. Plan View of Four-slide Automatic Wire-forming Machine

slides have dwells of 90 degrees. As these cams may be adjusted to any desired position with relation to the shafts, the movements of the tools may be regulated very closely.

Making the Tools and Starting a New Job

When the tools are to be made for a new piece of wire forming, the toolmaker usually receives a drawing of the piece, but it is a great help to him to also receive a sample of the work to be produced. He first studies the best way to face the tools in the machine, trying to get the simplest and strongest design that he can employ in the making of the tools.

The tools are generally made from low carbon steel, but for hard wire, spring wire or other stock that is liable to cause wear, the dies are made of tool steel, hardened and drawn to a brown color. To avoid marring the stock, as well as to guide the wire, grooves are cut in the faces of the tools to

* Associate Editor of MACHINERY.

fit the wire, wherever the tools come in contact with it. The center arbor, however, is not grooved, because the wire would not strip easily if it were. Wherever possible the grooving operation is done with a cutter similar to a small T-slot cutter, but many places must be chipped, filed and worked out

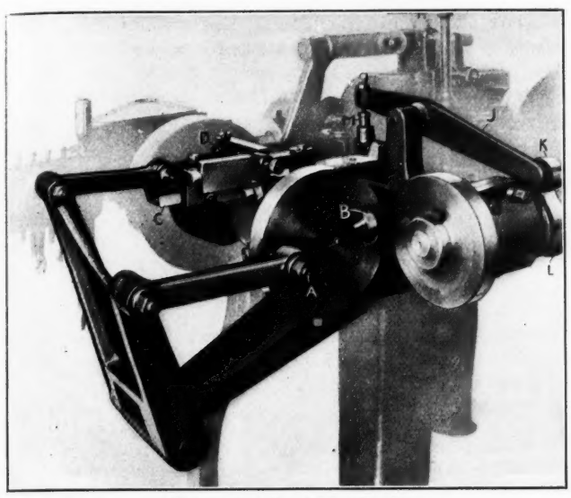

Fig. 3. Details of Wire Feed

by hand. It is an excellent plan to stamp each die with the job number and the position of the tool in the machine. This will save trouble in locating misplaced tools, and prevent blunders in setting-up the tools in the machine. After the dies have been completed, they must be put into the machine and adjusted; usually they must be altered until the piece produced is correct. One of the difficulties that must be contended with is the varying tempers of the wire that must be worked, and this trouble does not apply to spring wire alone.

An important part of the trying-out of a set of wire-forming tools is to ascertain the correct length of wire required to make the given piece. It is customary to figure out the length as closely as possible from the drawing, cut a piece of wire to this length, and bend it by hand to the shape required. If more stock is required, another piece, left a little longer, is tried, until the proper length is found. For spring wire, in addition to the developed length, the length must be increased an amount equal to one-half the diameter for each 90-degree bend, and one-fourth the diameter for each 45-degree bend.

a vise in holding the wire while being bent. It often happens that one or more of the slides are not required for the work, in which case they are drawn back as far as possible and allowed to run idle. The stripper is adjusted to push the piece from the center form just after the slides have started to pull back.

The wire is cleaned and lubricated, as it enters the wire straightener, by a piece of felt soaked in oil and held against the wire by a simple clasp spring. The speed of wire forming operations varies with the class of work; the production may range from 50 to 200 pieces per minute, according to the diameter of wire. For pieces of average-sized wire, up to 3/32-inch diameter, 100 pieces per minute is good production.

Peculiarities of Different Wire

Without doubt the most satisfactory kinds of wire to work are soft brass and copper, with soft steel a close third. The reason the soft wires are so easy to work is that the stock "stays where you put it." Half-hard brass is also an easy

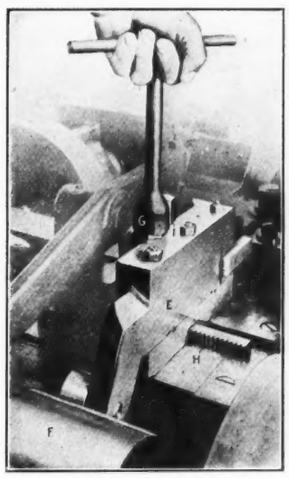

Fig. 4. Details of Cut-off

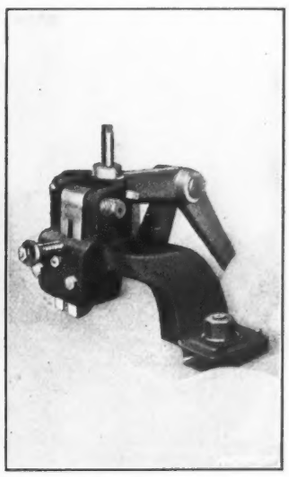

Fig. 5. Form-holder and Stripper

wire to form and is used largely on general work. Tinned and galvanized wires present difficulties in the form of lumps and rough places due to the tinning and galvanizing. These lumps interfere with the working of the tools and are apt to injure the faces of the dies.

All hard wires are troublesome to form. Hard brass, and especially phosphor-bronze wire, object to being "kinked up."

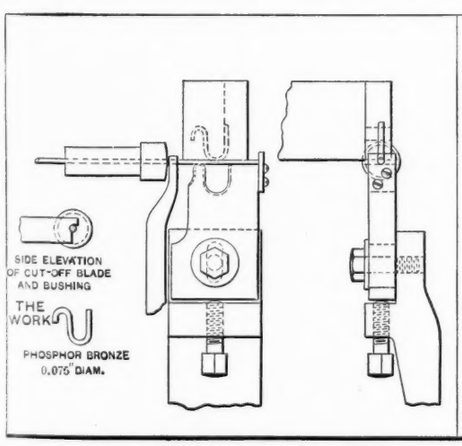

Fig. 6. Tools for a Simple Job of Wire-forming

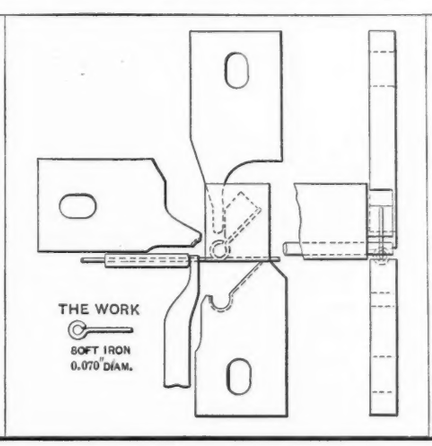

Fig. 7. Tools for Forming an Eye-pin

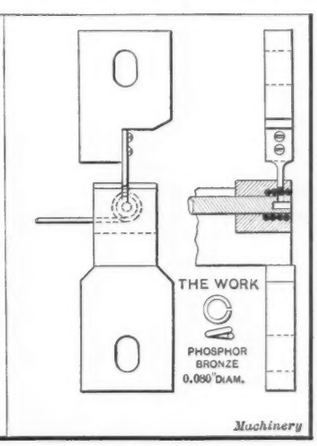

Fig. 8. Tools for Ring-forming

In setting up the cams on the machine, the feed should be given the first consideration, the feed, the grip and the tension on the straightener rolls being first adjusted. Next, the cut-off cam must be set so that the blade strikes the wire just as it comes to rest after being fed forward. The slides must then be set, and of these the front slide comes first. This slide should be set so that it will just catch the wire against the center die or form at the time it is cut off. The cam for the front slide has a long dwell, being designed so that it may be kept against the wire while the other slides are performing their work on the piece. Thus, the front slide acts like

This objection manifests itself by the wire springing away from the forms after being bent, and by slipping through the feed and grip. To obviate the first trouble, the angles in the forms are made a little more acute than the requirements call for, and as the wire will not hold the exact shape imparted by the dies, the result is usually satisfactory. In every case there is more or less "cutting and trying" to be done. To overcome the slipping of the wire, the tension of the feeding finger is adjusted so that the slide and finger will get a stronger hold upon the wire in pulling it through the rolls. It is a frequent occurrence to find that in the same shipment

of wire, different coils of the same grade will be of different tempers, necessitating the changing of the grip or tension rolls for each coil.

Steel spring or piano wire is the most difficult material met with in wire-forming. All the evils of hard brass and bronze are found in steel spring wire, and in addition it has a few bad features of its own. For small wire of this kind, especially, the dies must be hardened, or they will not stand up at all. The cut-off blade and bushing must be frequently ground to retain clean ends on the wire. The tension rolls must be adjusted to insure the wire coming through the cut-off bushing exactly straight across the front die, so that the dies will grip it in the proper position.

Ribbon stock, the name commonly applied to narrow sheet metal coming in coil form, may be conveniently worked in the automatic wire forming machine by altering the style of tension rolls on the straightener and providing suitable cut-off bushings and blades. As the machine is automatic, it is often possible to handle a sheet-metal job to better advantage than by the use of a press, in cases where bending operations are to be performed.

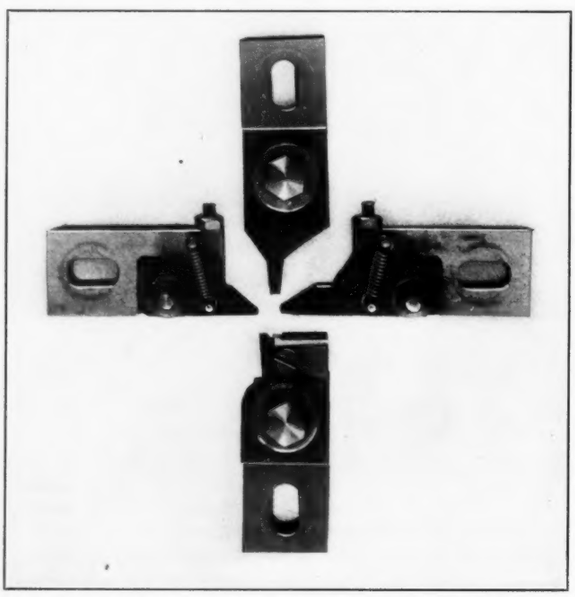

Fig. 9. A Set of Wire-forming Tools for a Very Small Link

When forming very light wire or thin ribbon stock, there is a certain amount of elasticity in the stock that causes it to draw back slightly if this "backlash" is not held in check. Between the releasing of the wire by the grip and the forward movement of the wire by the feed finger, there is just an instant when the hold on the wire is released, unless the timing is perfect. To obviate the necessity for minute adjustments of the cams to overcome this tendency, Mr. C. W. Kenerson, to whom the writer is indebted for assistance in preparing this article, has designed an auxiliary spring wire grip. This grip is placed just back of the feed finger upon the slide, and one of its halves is screwed to the slide frame. The other half slides on dowels driven into the first half. Springs between the two keep a steady tension on the outer half, which continually bears against the wire. Thus, at no time is the wire free to relax, and yet the pressure against it is not great enough to interfere with the feeding of the wire.

A Few Interesting Sets of Wire-forming Tools

In order to show the way in which wire articles are formed in the four-slide automatic wire-forming machine, a few representative sets of tools are illustrated. None of the jobs are very difficult, as will be gathered from the fact that the bending operations shown are all in one plane. Really difficult wire-forming involves bends in two planes.

A set of very simple wire-forming tools will undoubtedly be best for our first description. The double-bend hook shown in Fig. 6, together with the tools used in the machine, is a good example of a plain wire-forming job. The material is phosphor-bronze, 0.075 inch in diameter. As will be seen, but one of the slides is required for the bending. The forming tool, or die, as it is sometimes called, is mounted on the front slide. The method followed in holding the tools on the slides is also well shown in this illustration. An elongated slot in the tool permits a reasonable amount of adjustment by means of the set-screw behind the tool. The wire is cut off in the usual manner, the cut-off blade being off-set so as to cut the wire short enough for the pieces. The stop on the side of the front slide is necessary to steady the wire until the tools have gripped it firmly.

The wire feeds in and is cut off just as the front slide comes up, and is then caught between the projection on the center die and the tool on the slide. After the front tool has forced the wire into the center form, the slide retreats, and the stripper comes down and ejects the hook. In all of the illustrations the strippers are omitted for the sake of clearness. There is nothing complicated about the stripper for it is merely a piece of 3/32-inch sheet steel supported upon the stripper rod, serving to push the wire piece from the center die after the forming has been completed. In the drawings of the tools, the plan views are shown with the center die in place, as seen from above; hence the forming portions of this die are shown in dotted lines.

Tools for a Wire Eye-pin

Fig. 7 illustrates a familiar piece of wire bending that is often seen in many sizes and varieties. This particular piece is made of 0.070-inch iron and is 1½ inch long. To form this piece, three of the slides are used—front, back, and left. A point to be noted about this job is the movable arbor used in the center die when the eye bend is made.

The wire is fed in and cut off in the usual manner, the front die gripping the wire against the angular projection on the center die. At this time the central arbor is within the form and thus out of the way, leaving the path clear for the back tool to set the wire firmly into the depression in the front tool. As soon as this part of the forming has been done, the arbor drops into place and the left slide comes in, bending the end of the wire around this arbor and thus completing the eye. The front slide remains against the work while the other slides are at work. After the piece has been bent, the arbor that shapes the eye retreats into the center die, thus allowing the piece to drop without using a stripper.

Wire Forming Tools for a Small Ring

Fig. 9 shows a set of wire forming tools just removed from the machine. The illustration conveys a good idea of wire forming tools in general. These tools were designed to form a small link from 0.015 inch brass wire, the outside diameter of the link being only 3/32 inch.

It is evident that the wire must be cut off at a point just far enough from the first bend in the front dies to leave sufficient wire to complete the end of the piece. As the total length of wire required to form this link is about 5/16 inch, the wire must be cut off just 5/32 inch from the center of the front bend. It is obvious, therefore, that there is not room for a cut-off blade, so the cutting is done with a very thin strip of steel screwed to the side of the front die.

The order of operations is as follows: The front die comes up to the wire, forcing it around the arbor in the center die (not shown), the side slides come in together, shaping the sides, and, finally, the back die completes the ring. As these tools are delicate for a machine of this character, the side tools are hinged, being kept in normal position by spiral springs. This construction gives more latitude in adjusting the tools, for with rigid tools the slightest amount of overpressure would break the tips of the tools.

Tools for a Miner's Lamp Hook

The tools for the special hook shown in the center of Fig. 10 are a little out of the ordinary in some respects. In this case there is plenty of room for a separate cutting-off tool, and the wire is cut independent of the front slide. The front die, as usual, makes the main bend and holds the wire against the center die while the left side die comes in to shape the sides of the hook.

The right and back dies are not required for shaping the hook, but they come into play in trimming the end of the hook. It is necessary that the square end of the hook be trimmed off very clean and square. This operation is accom-

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plished by clamping the back slide stationary and mounting on it a hardened blade, the end of which is ground to match the blade on the left slide. The end of the hook is supported from the right slide by a pin that rests against the hook, and moves with the same speed as the trimming blade.

The end of this hook is pointed before being bent. The tools for the pointing are shown in the upper left-hand corner of the illustration. They are located at the cut-off, and come together on the end of the wire exactly like a pair of dies. The dies are relieved around the impressions, so that the

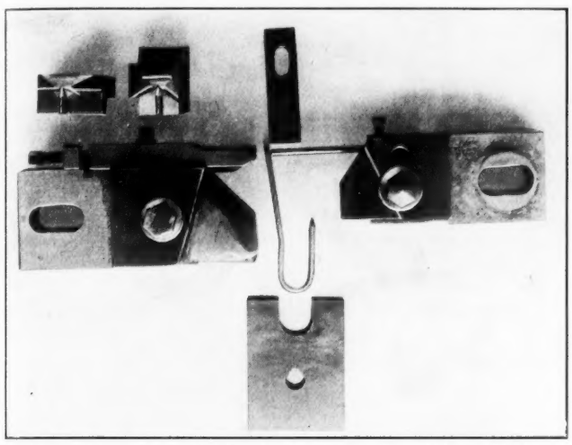

Fig. 10. A Set of Wire-forming Tools for a Miner's Lamp Hook

excess metal is trimmed off as the point is formed. This method does not produce a very good point, but is satisfactory where a cheap blunt point is required.

Tools for Forming a Tag-hook

While none of the wire-forming tools shown are really complicated, the tools shown in Fig. 11 are perhaps a little more intricate than any of the others that have been shown. The piece to be made is of bronze wire, 1/16 inch in diameter, having an eye at one end and a special form of hook at the other. The wire is fed in through the cut-off bushing and cut off as

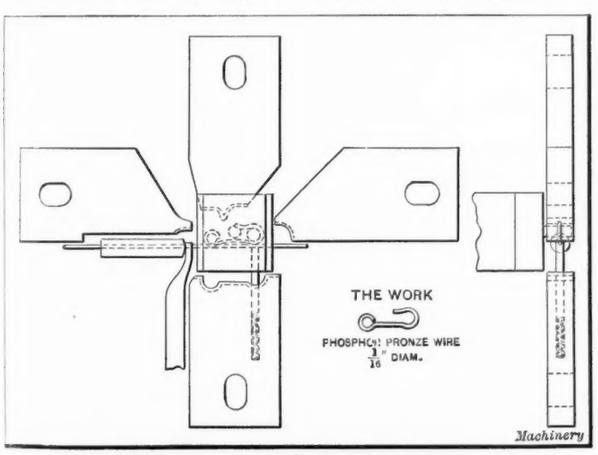

Fig. 11. Tools for Forming a Special Hook

usual. As the wire is cut off the spring plunger in the front slide presses the wire against one of the pins in the center form. Still maintaining this hold, the front slide comes in, making the back side of the hook complete. Then the two side slides, right and left, working together, form the ends of the hook, leaving but little for the back slide to do. As in most wire-forming operations, the operation of the back slide comes last, completing the hook. The three forming pins are held by set-screws, and the work is stripped as previously described.

Tools for an Oval Coupling

A set of tools that introduces the use of the movable center arbor is illustrated in Fig. 12. These tools produce the copper coupling shown, using ribbon stock, 7/16 inch wide and 0.030 inch thick. The operation of these tools involves all four slides and the movable center arbor. The object of a moving form is to lessen the risk of breakage on small work in case the adjustments of the slides are not exactly right.

The stock feeds in through the cut-off bushing, and runs in a channel cut in the face of the front die. As soon as it strikes the stop it is cut off and caught by the front die against the center form. At this time the back die is bearing against the center arbor, but as the front die advances, the back die retreats at a slightly slower rate; thus the front die very gradually closes the metal around the front of the arbor. By the time the arbor has reached the limit of its travel, the front die has closed the metal closely around the arbor, and by means of the dwell on the cam, remains stationary for a quarter of a revolution. Meanwhile, the back die recedes a little farther, leaving the rear side of the arbor clear while the two side dies complete the forming of the coupling.

Making Links on a Wire-forming Machine

An ingenious die for making links is shown in Fig. 8. Links may be made by ordinary wire-forming methods, but it is sometimes troublesome to make a perfect joint at the ends of the stock. This method does not make a closed joint, but the ends are exactly in line and the link requires only a slight side twist to make it perfect. Perhaps it would be

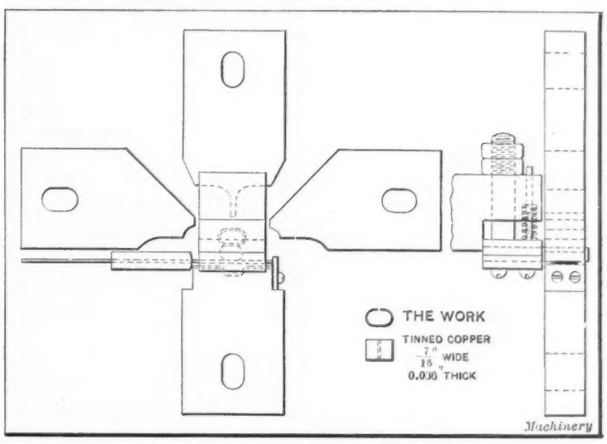

Fig. 12. Tools for Forming an Oval Coupling

plainer to say that the links are the same as if produced by winding a close coil and splitting it with a saw, except that there is no stock lost on account of the width of the saw.

The tools for this work are very simple, requiring but one slide for forming, although the front slide is used as a support, being permanently clamped in one position. The essential part of the tools is a block that we may call the center die, fitted to the form holder. This block has a hole running through it lengthwise, and in a portion opposite the tops of the slides, a "thread" is cut with a pitch equal to the distance from one convolution to the next of a close wound coil of the size of the wire. The thread is left-handed, and is cut with a tool having a semi-circular nose of the same size as the wire. At the same height as the first turn of this groove, a hole slightly larger than the wire runs toward the wire feed, tangent to the coil.

Below the two or three turns of the thread a hole is bored out to the body size of the coil. A central arbor of the same diameter as the inside of the link to be formed extends through this hole. The lower end of this arbor is bored out as shown, and a small square opening, slightly larger than the diameter of the wire, is cut in one side. The end of the arbor is hardened and tempered. The arbor is held in its proper position in the block by means of two taper pins. The square opening in the arbor faces the path of the rear die, and a clearance hole is made in the enclosing block to admit the punch that operates on the rear slide. This punch is made of sheet steel, so that it can be easily replaced if broken, and it is closely fitted to the die-opening in the arbor.

The wire is started in the hole leading to the internal groove, and by means of the feed it is advanced one turn plus an additional one-eighth inch. When the back slide comes in, which is the only slide that moves, the punch cuts off this short additional section, thus allowing one ring to drop from the hole. No stock is missing from the circumference of this ring, because enough additional stock has been supplied to make up for the piece cut out. Naturally, these rings may be turned out very fast by this method, for with but one slide working, the machine may be speeded up considerably.

THE BENCH LATHE AND ITS USES

By EDWARD K. HAMMOND*

The modern bench lathe finds wide application in the manufacture of small metal products, such as parts of the mechanism of meters and clocks, and in fine tool work, where its facility of operation and its accuracy make it an ideal tool. The bench lathes have been developed to the same high standard of efficiency as the heavier types of lathes, and the design of various attachments has broadened the field of these machines so that they are able to handle a wide range of work. The operations described in the following are performed on the Cataract precision bench lathes, manufactured by Hardinge Bros., Chicago, Ill. In addition to their adaptation to regular bench lathe work, these machines may be equipped with attachments for milling and grinding, for chasing, cutting, and milling screw threads, and for turret work, filing, and a variety of other operations. Besides building bench lathes and attachments, the Hardinge plant is engaged in the manufacture of watchmen's time clocks and watch-maker's tools, and in a great variety of contract work. Consequently, a description of some of the machining operations handled by bench lathes in this company's shop will show the rapidity and accuracy with which these machines can deal with the work for which they have been designed. Before entering upon the uses of the bench lathe, however, a brief description of the important features in the design of the Cataract lathe will prove of interest.

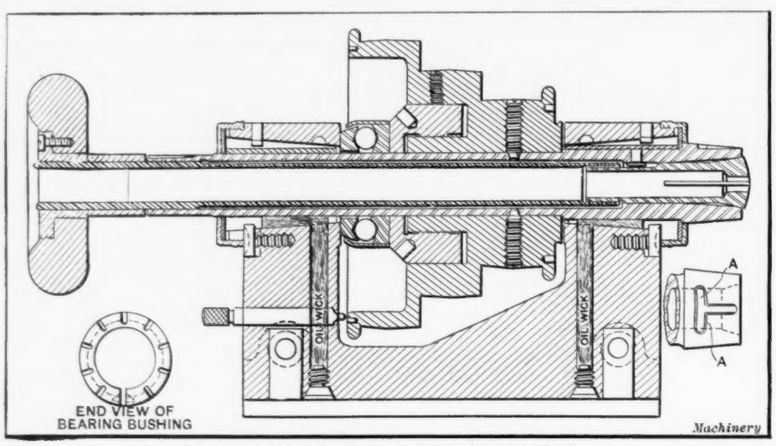

Fig. 1. Cross-sectional View of Bench Lathe Head

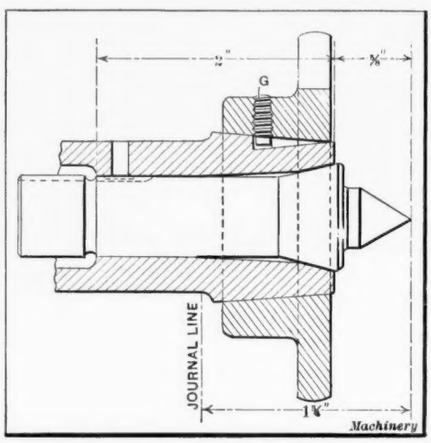

Fig. 2. Detail View of Spindle Nose

In designing machinery, it is important to combine the greatest number of advantages without leaving out any features of vital importance or complicating the machine with unnecessary fixtures. Thus, in the case of the bench lathe, the best equipment is the one which can handle all of the work for which it is required without having any unnecessary attachments. Hence all the parts and attachments should be interchangeable. This enables a shop operating several lathes to use a given attachment on any machine on which it may be required; it also makes it possible for additional fixtures to be purchased from stock at any time.

Experience has shown that a proper countershaft equipment adds greatly to the efficiency of any bench lathe. In order to obtain the best possible results, the countershafts should be mounted on a pipe frame attached to the bench and ceiling. This frame is made of ordinary 1¼-inch gas pipe, threaded at the ends for feet that are bolted to the bench and ceiling. The countershafts used with these frames are designed with sockets which fit the pipe frame, and can be adjusted to any desired point. This makes it possible to use an endless belt for the three speeds of the countershaft and to adjust the belt tension by raising or lowering the countershaft on the vertical supports. With this system, only one belt is required for driving from the line-shaft, whether one, two, or three lathes are mounted on the same bench, and a motor may be attached for independent drive. Another advantage of this system is that the pipe frame offers very little obstruction to the light in cases where the lathes are set up in front of a window to take full advantage of the daylight.

* Address: 9620 Hoyne Ave., Chicago, Ill.

Probably the most important consideration for the user of bench lathes is that of the capacity and strength of the chucks and the spindle which carries them. The spindle must be designed to resist any strain which the gripping power of the chucks may place upon it. It should be of the hollow type in order to permit operating on bar stock.

The hollow spindle of the Cataract lathe is designed for draw-back chucks for handling bar stock, and for jaw chucks and wheel chucks for miscellaneous classes of work. The spindle is designed with the patent nose shown in Fig. 2, which drives either in the right- or left-hand direction. The absence of threads enables the spindle to be hardened and ground true, and as the nose is smooth, it can easily be kept clean. Referring to Fig. 2, key *G* in the chuck is slipped into the keyway in the spindle nose. The chuck is then turned so that the key enters the groove *A*, Fig. 1, which tightens the chuck upon the taper nose of the spindle. The drive is obtained entirely through friction between the spindle nose and the chuck, the key taking no part in the drive after the chuck has been tightened.

Lubrication of the bearings is accomplished by an arrangement of oil cups and wicks as illustrated in Fig. 1. The oil cups are placed at the back of the head and communicate with the bearing through a 9/32-inch hole. This hole contains the wick which terminates in a recess cut in the bottom of the journal. As the oil has to pass up through the wick to reach the bearing, it is always quite clean, the action of the wick being equivalent to that of a filter. By this arrangement, the oil wells are constantly supplying oil to the bearings in just the proper quantity to secure perfect lubrication. The action of this device is so perfect that machines lubricated in this way may be run for at least a month on one supply of oil.

The Use of the Bench Lathe

One of the regular products of the Hardinge factory consists of a brass gear for use on automobile magnetos. As shown in Fig. 3, these gears have four spokes, the space between two of the spokes having sufficient metal left for the holes *A* and *B*. A slot is milled in one of the spokes adjacent to the holes *A* and *B*. The centers of the two holes must be exactly 25 degrees apart, and the center line of the slot must be 45 degrees from a point midway between the holes *A* and *B*.

The regular bench lathe equipment, provided with a compound rest and a three-jaw chuck, is used for the first machining operations on the gear blanks, which are in the form of rough castings. These blanks are machined in lots of several hundred at a time and the first step consists of mounting each successive blank in the chuck, facing one side of the blank and machining the inside of the rim. After this operation has been completed on all the blanks, the jaws of the chuck are adjusted to hold the blank by the machined inside of the rim. While held in this position, the other side of the gear is faced, and the face of the gear machined. The cored hole in the center of the gear is then bored by means of a one-lipped tool held in the lever tailstock. The spindle of this tailstock is designed to hold different tools, and a lever is provided which enables the spindle to be advanced to bring

the tool into contact with the work. The compound rest used in these operations has hand feeds with dials reading to 0.001 inch. The two dial feeds enable the entire side of a gear wheel to be machined at one setting, still keeping the dimensions within the most rigid specifications.

After these machining operations have been completed, the blanks are transferred to a Hardinge automatic gear cutter.

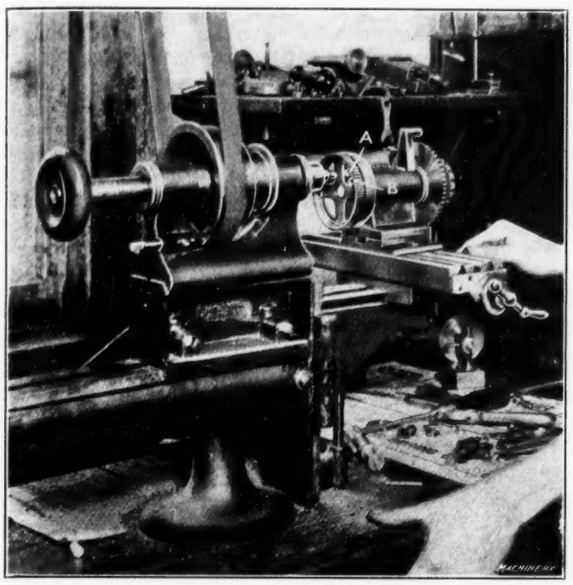

Fig. 3. Boring Holes A and B by the Bench Lathe Milling Attachment

This machine is equipped with a special arbor which has been designed to locate the space between two gear teeth exactly opposite the center of the spoke in which the slot is to be cut. This is necessary in order that the slot may be properly located in the jig used in the milling operation. The blanks are mounted on the arbor of the gear cutter in stacks of seven, and after the machine has been started, they require no further attention until the operation is completed.

The Milling Attachment

After the teeth have been cut, the work is transferred to a lathe equipped with a milling attachment, as illustrated in Fig. 3. In setting up the milling attachment on the lathe,

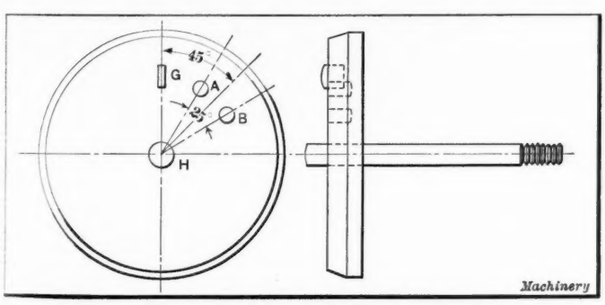

Fig. 4. Jig used for Locating the Holes A and B, Fig. 3

the frame is mounted at the right-hand end of the bed and is held in position by means of two eccentric-headed bolts. The lathe head is then removed from its usual position and mounted on the frame of the milling attachment. This brings the lathe spindle over the table of the milling attachment, where it serves as the spindle of the milling machine. The countershaft for driving a machine which is to be used with a milling attachment, is provided with a second pulley. This pulley is raised to the proper height above the regular lathe pulley so that the same belt may be used for driving the lathe and the milling attachment. All of the feed-screws of the attachment have independent micrometer dials reading to 0.001 inch. An angular attachment has been provided for use with this milling attachment, which is secured to the faced edge of the table by means of eccentric-headed bolts held in the T-slot. The head and the tailstock of the attachment can be mounted on this, and swung around to any angle with the table, as indicated by the graduated index on the attachment. This enables milling to be done at any angle which may be required.

The jig shown diagrammatically in Fig. 6 is used for the first milling operation on the gears, which consists of cutting the slot in the spoke, the jig being used to locate the slot in the proper relation to the holes *A* and *B*. This jig is clamped to the table of the miller. The pin *D* fits into the hole in the center of the gear; second locating pin *E* is situated as shown in the illustration. In mounting the work in this jig, after pin *D* is fitted into the center hole, the gear is rotated until the spoke comes into contact with pin *E*. This brings the gear into approximately the correct position for milling the slot. The final setting is then effected by the locating screw *F*. This screw is advanced into the space between the gear teeth, which was located opposite the center of the spoke when the teeth were cut. The tapered end of the screw acts as a wedge between the teeth and rotates the gear the the required amount to bring the center of the spoke under the milling cutter. The work is then fed up against the milling cutter and the slot is milled.

The next step is to finish the holes *A* and *B;* the jig illus-

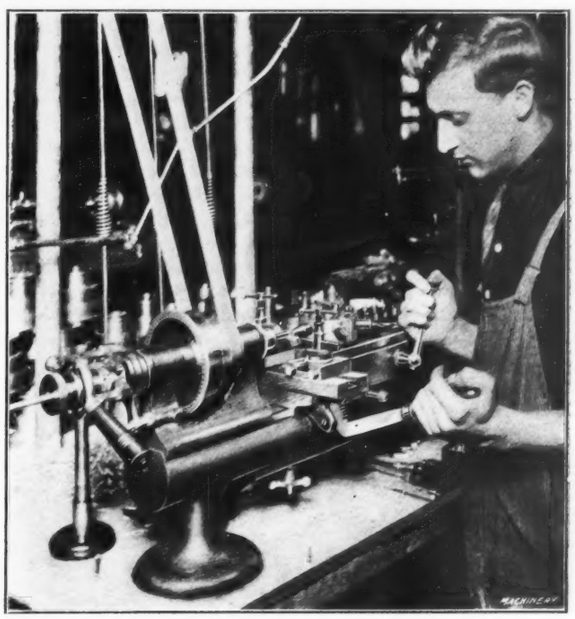

Fig. 5. Bench Lathe equipped with Turret Attachment, Double Tool Cross-slide and Automatic Chuck-closer

trated in Fig. 4 is used to locate them in the proper relation to each other and to the slot. The jig in this case is mounted in the head of the milling attachment by means of the threaded shank that fits into the draw-in spindle. The gear is carried by the central pin *H*. The pin *G* fits into the slot in the gear spoke and acts as the point of reference in locating holes *A* and *B*. The gear is laid out with a line passing through the

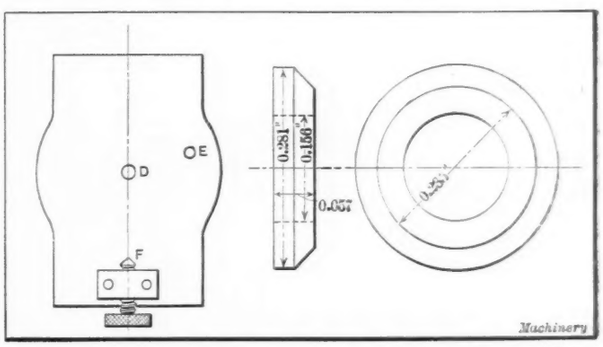

Fig. 6. Jig used when Milling Slot in Gear in Fig. 3

Fig. 7. A Small Brass Washer made on the Turret Lathe

slot and the center of the gear, and is then clamped in the jig and the latter rotated until the datum line is perpendicular with the table of the miller. The dividing head is then used to locate hole *A* at 32½ degrees from the slot, and with the gear in this position, the work is traversed to the

boring tool in the spindle and the hole is bored. The work is then withdrawn from the tool and rotated through another 25 degrees, and hole *B* is bored.

The jig is now removed from the milling attachment and replaced by a wheel chuck of the proper size to hold the gear. The boring tool in the spindle is replaced by a tap, and the central hole in the gear tapped, thus finishing the machining operations.

An Example of Turret Work

In the manufacture of small screws, studs, and many other pieces, there is a series of operations, such as centering,

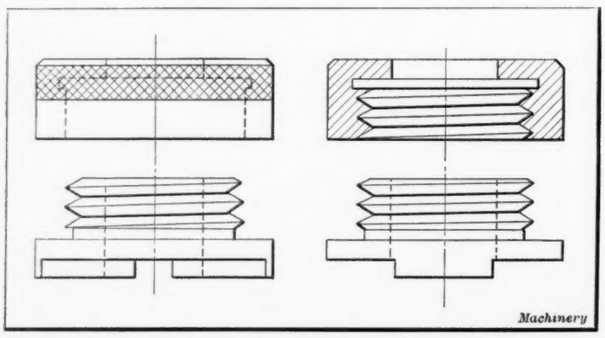

Fig. 8. An Example of Work done by the Chasing Attachment

drilling, and tapping, where a marked advantage is secured by having a series of tools available for performing successive operations on a piece of work at one setting. In order to meet the requirements of such work, the bench lathes mentioned have been equipped with a six-hole turret attachment and a double tool cross-slide, thus giving the machine a capacity for eight tools. The turret is mounted on a slide and is provided with rack and pinion feed, as this design has been found to be best suited for the requirements of the sensitive work which is done on a turret of this size. An adjustable stop is placed at the back of the slide to check the tools at the desired point, or independent stops may be used for each

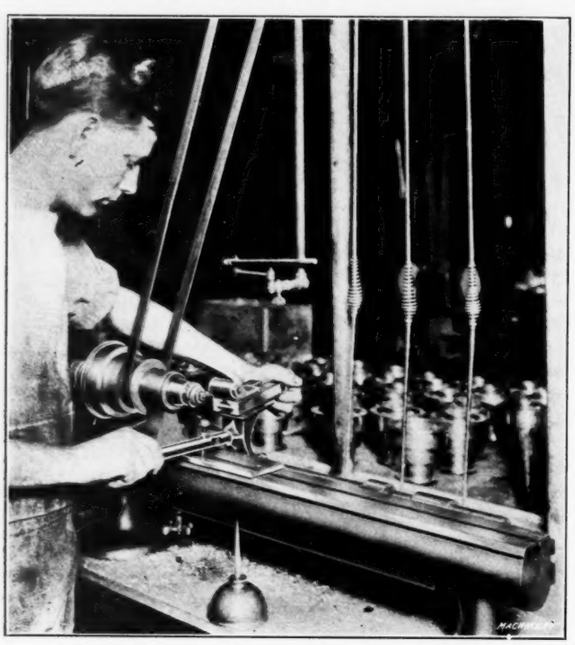

Fig. 9. Bench Lathe equipped for Thread Chasing

tool. The double tool cross-slide has a T-slot running across it in which the two toolposts are mounted. Each of the toolposts are secured by two bolts and may be adjusted to any height by means of a threaded block at the base. The cross-feed of the slide is operated by means of a hand lever, and adjustable stops are located at each end of the slide.

An automatic chuck-closer is used in connection with the turret and double tool cross-slide when operating on bar stock. This device is used in place of the regular draw-in spindle, and closes the chuck by simply throwing over a hand lever. The chuck-closer fits over the outside of the spindle at the rear end and is keyed in position. It enables the machine to be run continuously, without stopping to adjust the chuck, the stock being fed through the spindle as required.

A bench lathe equipped with these three attachments is illustrated in Fig. 5. This machine is used for making small brass washers for clock movements, one of which is shown enlarged in Fig. 7; these washers are made from bar stock. Three tools are used in the turret, namely, a stop, a centering tool, and a drill for the hole. A forming tool for beveling the edge of the washer, and a parting tool for cutting it off from the bar, are used in the double tool cross-slide.

With the stock in the spindle and the attachments adjusted, the operator throws over the lever of the turret attachment with his right hand. This brings the stop against the end of the stock and pushes it back through the spindle until the stop on the turret slide is reached. The operator then closes the chuck by throwing over the lever on the automatic chuck-closer with his left hand. He then throws over the lever on the turret to center the stock, and does so a second time to drill the hole. The lever of the double tool cross-slide is then pushed down to bring the forming tool into contact with the work to bevel the washer. The final step then consists of pulling up the lever on the cross-slide to bring the parting tool into action to cut off the finished washer from the bar.

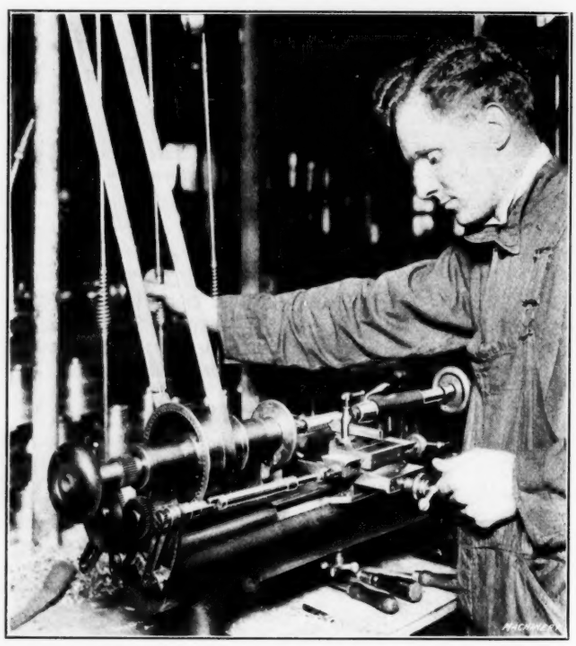

Fig. 10. Cutting a Special Tap with the Screw-cutting Attachment

It will be noticed from the preceding description that the stops on the attachments regulate all of the operations, so that the operator does not have to pay any attention to the dimensions of the work. This greatly increases the output on work of this character. On the operation just described, an average workman can turn out three hundred washers per hour. It is a relatively easy matter to design the necessary tools to handle any given piece of work, and after such tools have been made, a turret lathe equipment of this kind can be used to great advantage in the manufacture of many pieces that are now being produced in a far slower way.

The Chasing Attachment

The chasing attachment which has been designed for use with this bench lathe is bolted to the faced and T-slotted surface at the back of the bed, adjustable brackets and eccentric clamp bolts being used for this purpose. The chasing bar extends the entire length of the bed and is provided with an adjustable collar for governing the position of the cutter when engaging the work. The tool-holder is adjustable along the chasing bar so that it can operate in any position over the bed. This tool-holder carries circular cutters for both inside and outside thread chasing, and has a finely graduated feed-screw for making adjustments. The regular cutters used with this attachment work in a hole of from ¼ inch up, but

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special cutters may be made to chase a thread on the inside of a much smaller hole. The stop collar on the chasing bar may be set so that it stops the cutter at any desired point, and this makes it possible to work a clean thread right up to a shoulder on either inside or outside work. This collar can also be set to prevent the cutter from injuring the thread on the opposite side of a hole when the tool is being withdrawn.

The lead-screw used with this attachment is fluted for a distance of 1 inch from the end, thus forming a hob for cutting the leading nut. In cutting a nut in this way the blank is fastened in the socket carried by the chasing bar, and is then held against the hob, which is driven by the regular gearing provided for driving the attachment. The lead-screw is carried on a geared mandrel, and the lathe can be arranged to cut from one to eight integral multiples of the number of threads on the lead-screw.

This attachment offers a rapid method of cutting threads, as the leading nut can be lifted out of engagement with the screw to allow the tool to be quickly returned by hand to the beginning of the cut, without the necessity of either stopping

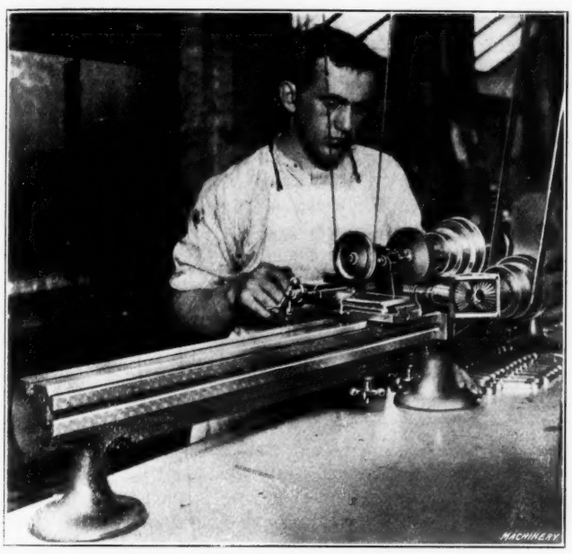

Fig. 11. The Thread Milling Attachment, showing the Driving Mechanism

or reversing the lathe. The attachment is so arranged that it does not interfere with the regular lathe work or with that of any other attachment. Consequently it can always be kept mounted on the machine, where it is ready for immediate use.

A description of one job which is regularly handled in the Hardinge factory will explain the use of the attachment. In machining the threaded block shown in Fig. 8, which is used for adjusting the height of the toolposts on the double tool cross-slide, the block is made in two parts. The blanks from which the bases are made are first mounted in a wheel chuck, carried in the spindle of a lathe equipped with a chasing attachment, and the hole for the toolpost is bored and faced. After this operation has been completed the work is mounted on an arbor chuck, where it is faced and necked. The tool-holder on the chasing bar is then adjusted to bring the tool into the proper position and the stop collar is set to check the tool when it has reached the shoulder. After making these adjustments the chasing tool is brought into service, as shown in Fig. 9, and the thread is chased. The work is then transferred to a miller, where the base is milled to fit in the T-slot of the cross-slide. The knurled cap for these blocks is started on a screw machine, which roughs it out on the inside and then cuts the piece off from the bar stock. The work is then transferred to a bench lathe and mounted in a wheel chuck, after which it is bored and necked. The chasing tool is then brought into action and the thread is chased on the inside of the cap. The caps are later mounted on a plug and knurled. After this operation has been completed the caps and bases are screwed together and faced off, thus completing the machining operations.

The Screw Cutting Attachment

The screw cutting attachment used for cutting a great variety of threads is illustrated in Fig. 10, engaged in making a special form of tap. It will be noted from this illustration that the attachment consists of a universal-jointed rod, which is geared to the lathe spindle by gears mounted on a bracket screwed to the end of the bed. Change gears are provided with this attachment which make it possible to cut from 5 to 150 threads per inch. The feed of the tool over the work is obtained by means of the universal-jointed rod, which fits over a nut on the end of the longitudinal feed-screw in the regular compound rest, and as this compound rest may be set to any desired angle by the graduated swivel, it is possible to cut a thread on any taper. The work is held between centers and driven by means of a driving dog and plate, as shown in the illustration.

How the Thread Milling Attachment Operates

The bench lathe equipped with a thread milling attachment has been found especially useful for milling small worms, threaded parts of meters, and for a variety of other similar work. This attachment is illustrated in Fig. 11, engaged in threading a part of a meter mechanism. The lathe equipped for screw cutting, as illustrated in Fig. 10, provides for the feed of the milling cutter, which is carried on a spindle running in a bearing bolted to the top of the compound rest. The driving pulley on this spindle is belted to a pulley on the countershaft, as indicated in the illustration. The speed of the work is regulated by the worm-wheel mounted on the lathe spindle nose. This worm-wheel is driven by a worm which in its turn is driven by the pair of bevel gears and a cone pulley belted to the countershaft, as shown. The bracket which carries the bevel gears and cone pulley is held in the same T-slot that carries the thread chasing attachment.

An automatic stop is provided which can be set to throw the worm out of engagement with the wheel and thus stop the feed of the cutter at any desired point. A little ingenuity on the part of the mechanic will enable him to vary the minor details of this equipment so that he can accomplish anything in thread milling within the capacity of the machine.

* * *

UNIT COSTS OF CONCRETE BUILDINGS OF VARIOUS TYPES

Lockwood, Greene & Co., architects and engineers for industrial plants, Boston and Chicago, estimate the approximate unit costs of reinforced concrete buildings of various types as per the figures in the table below. These figures coming from a firm that has had such an extensive experience in this line are of more than usual value.

Type of Building	Dimensions	Live Load, Pounds per Sq. Ft.	Cost above Foundation		Cost including Foundation	
			Sq. Ft.	Cu. Ft.	Sq. Ft.	Cu. Ft.
Mch. Shop..	120x50 4 sto.	150	$1.05	$0.08	$1.17	$0.09
Mch. Shop..	220x100 1 sto. sawtooth skylights		1.65	0.09	1.75	0.10
Cartridge Factory...	223x56 2 sto.	300	1.40	0.09	1.55	0.10
Cotton Mill.	550x129 2 sto.	75	0.99	0.07	1.06	0.075
Weave Shed	341x231 1 sto. sawtooth skylights	125	1.66	0.064	1.79	0.07
Power Ho...	90x62		2.53	0.115	2.67	0.12
Store Ho....	181x56 4 sto.	150	1.08	0.065	1.15	0.07
Store Ho....	256x100 12 sto.	150	0.90	0.09	0.98	0.105
Store Ho....	223x56 2 sto.	300 and 1000	1.20	0.08	1.35	0.09

Coal pockets above 3000 ton capacity cost from $6.00 to $7.50 per ton. Reinforced concrete stand-pipes above the foundation cost from 2½ to 3 cents per gallon.

* * *

An English contemporary mentions that of every $100 paid for employers' liability insurance in Germany, $77.70 is returned to injured workers or their dependents; $9.50 goes to a relief fund; and only $12.80 is used for the administration of the insurance funds.

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MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition, $1.00 a year, which comprises approximately 700 reading pages. The Engineering Edition—$2.00 a year, coated paper, $2.50—contains all the matter in the Shop Edition, about 300 pages a year of additional matter and forty-eight 6 x 9 Data Sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. The Railway Edition, $2.00 a year, is a special edition including a variety of matter for railway shop work—same size as Engineering and same number of Data Sheets.

MAKING STEEL BALLS

The series of articles on steel ball making, beginning in this number, should be of unusual interest to all classes of readers because of the common use of the product. Written by an engineer of international reputation they have all that which goes with the work of an acknowledged authority. Mr. Grant is the designer of the principal machines used in making and finishing balls, and has equipped the principal ball making plants in America and several abroad. His father, a well-known machine tool designer and builder, did pioneer work in ball-making and has ably assisted in the development of ball-making machinery.

To make a steel ball polished and spherical within one-ten-thousandth inch limits, is no easy task. We doubt that any toolmaker using the common machine tools can make a one-inch steel ball, hardened, tempered, polished, free from all flaws and perfectly spherical within these limits. But granted that it can be done, attempt the more difficult task of making a one-fourth inch ball, and when that is accomplished, let the expert try making a thousand—nay, a hundred thousand. This is manifestly a class of work that absolutely requires special machinery—machinery of a type unlike the common machine tools used for the most difficult and accurate toolmaking.

The paucity of published matter on ball-making and the inherent interest of the machines and methods make these articles notable contributions to the science of mechanical engineering. MACHINERY feels honored in being selected as the journal fitted to present these articles.

* * *

THE "EFFICIENCY ENGINEER"

The last decade has been marked by the development of the investigating spirit in engineering work with reference to the promotion of greater efficiency of men and methods. This development was early given the name of "scientific management," simply because the elements of production were segregated and classified. The term is unfortunate in that it causes many who pass snap judgment on everything new to them to consider it as being something impracticable and unsuited to ordinary factory conditions. As a matter of fact, so-called "scientific management" is simply engineering skill applied to specific problems for the purpose of securing higher efficiency. It secures higher efficiency by eliminating unnecessary movements, providing proper tools, giving simple and accurate directions, and paying workmen higher wages.

Now if "scientific management" is a misnomer, how much more so is the term "efficiency engineer." The natural assumption is that a new race of engineers has been developed whose sole idea is efficiency. But any engineer worthy of the name must prove his efficiency. His training is, or should be, such as will enable him to produce a desired result easier, quicker, cheaper and better than the untrained man. Why then should any engineer arrogate to himself the magic word "efficiency" when to deserve the appelation is, and always has been, the desire of the ambitious engineer?

Of course a different order of experience and executive ability is required to carry on the manufacture of typewriters, for instance, than to erect a steel frame building, and the system of management may differ widely in details—but not in principle. No doubt certain engineers can specialize advantageously on certain phases of management, but with the famous definition of Tredgold: "Engineering is the art of organizing and directing men and controlling the forces and materials of nature for the benefit of the human race" before them, let them take some other special name than "efficiency engineers."

* * *

A MODERN CONCEPTION OF BUSINESS

The ethics of a horse trade are too well known to need description. It is *caveat emptor*—let the buyer or trader beware. The old idea of a business deal was the same; once consumated, there was no backing out. The buyer had to be content with his purchase, no matter how badly it fitted his needs. When the modern department store principle of "money back if not satisfied" was introduced, it meant more than a mere departure from the established methods of selling dry-goods or groceries. It embodied a new system of trade ethics that is destined to permeate every avenue of trade and business relation.

In the engineering world the idea is gaining ground that the selling of machines or apparatus is the selling of service. If the machine does not meet the buyer's need he has not secured the service that he wanted, and it is up to the concern to give it to him. Some go so far as to make the apparatus a secondary matter. They contract to furnish a service, and the concrete form in which it will be delivered may not be known to anyone when the contract is made, and becomes known only after those particular needs are studied in detail and a service to fit them has been planned.

The machine tool business lacks somewhat of homogeneity in rendering complete service. Jones sells Brown a boring mill, Smith sells him a lathe, Gray sells him a milling machine, and so on. Finally Brown has an aggregation of tools more or less well fitted to his particular needs, depending upon his ability as an organizer and engineer. What Brown wants is not a machine shop as such, but a means of securing a result; it may be the building of steam engines or cream separators. How can he get the best service? Only from the cooperation of those who specialize in the making of machine tools with a full appreciation of the proper relation of their tools to other machines and the general conditions of shop practice.

* * *

THE JOURNEYMAN

Years ago the approved method of learning a trade was to indenture the apprentice for a term of years, during which he was virtually the chattel of his master. He worked for no pay, save his board and clothes, and in some cases even paid a premium for the privilege of serving an arduous apprenticeship. When his time was served he became a journeyman, that is, one who traveled from shop to shop to gain experience and knowledge of methods not taught or known in his master's shop. These were years of privation and hardship, but they were endured to the end that he might become a master workman.

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The tradition still survives that a mechanic must work in more than one shop to be a good all-around workman; and it is largely true, but the necessity for a man to travel to know the mechanical world no longer exists. Some of the ablest mechanics have worked in a few shops or in only one, but they have an advantage—a means of education—that the old-time workman did not possess, and that is the trade journal. The modern trade journal of the best type brings to him the news of the world of trade, and gives him an outlook that he could never acquire by simply traveling from shop to shop.

But unfortunately not all men are fitted to absorb from the printed page what they would readily mentally grasp in concrete form. That which fits them is early education. Hence the importance of continuation schools and other educational means that inculcate habits of reading and understanding in apprentices. The workman who can read a blueprint, a trade catalogue, or a technical journal has at his command the elements necessary for success in his calling, if his personal equation is of that quality which commands common respect.

* * *

SAVING TIME IN MACHINE WORK

The laying of bricks is one of the oldest arts dating back into the past. Until the last decade no one had the temerity to intimate to the skilled and conservative bricklayer that there was even a remote possibility of conserving his effort, making his work easier and enabling him to lay more bricks in a day. But it was done by Gilbreth, who devised ways and means for cutting out movements of the hand and body.

This lesson has not been lost on mechanical engineers. The fact that even a bricklayer's work can be simplified, made easier and more productive by eliminating motions not absolutely necessary, has set many minds at work.

In drilling holes, for example, the operator must pick up the piece, lay it on the table, clamp it in place, seize the spindle lever and pull the drill down to the work; and throw in the feed. When the hole is drilled the movements are repeated in reverse order. Now the handling of the work by the operator may be regarded as absolutely necessary in most cases, but a drilling machine can readily be made to perform automatically the functions of lowering the spindle, feeding the drill, throwing out the feed and raising the spindle, and rotating a turntable carrying the work parts.

The carrying out of that idea has resulted in a drilling machine in which all the functions are automatically performed so far as the movements of the drill, feed mechanisms and table are concerned. The work of the operator is simplified to almost the last degree, being the placing of parts on the revolving table, clamping in place, unclamping and removing the drilled pieces.

The example has much significance, and while the principle is by no means new, it has not yet been carried out to the extent that practicable and economical design calls for.

* * *

PLANETARY REDUCING GEARS

A form of back or reducing gear that has been used frequently in machine construction is that having a spur gear meshing with two or more compound gears mounted on a spider, which, in turn, mesh with a smaller spur gear on the driving shaft. When the spider is locked stationary, the speed of the driven shaft is reduced in the continued ratio of the driving gear, the compound gears and the driven gear. When the gears are locked and the spider is released, the driving pulley and the gears and shaft revolve as one.

While on the face this form of reducing gearing appears to have the advantages of compactness and outward simplicity, it is not to be generally commended. In the first place the construction is essentially weak. The space available for the reduction gears is small, and an adequate support for the bearing studs is not available—that is, support for both ends of the studs. Another and perhaps more serious fault is the difficulty of setting the studs so that all the gears carry their due proportion of the load, the result commonly being that one gear carries the larger part of the load until destructive wear has developed.

Of course it will be objected that in the first-class construction the setting of the gear studs will be properly done, but unless jigs and fixtures of rather costly construction are provided, it is not so easy to accomplish as it might seem. Where reducing gears of this form are made in comparatively small numbers, the methods common to the job shop are likely to be employed—with the resulting deficiencies mentioned.

* * *

A MACHINE SHOP WITHOUT COMPRESSED AIR

By FRANK RICHARDS*

A month or two ago the writer made a call at a machine shop with which he was quite familiar some twenty-five years ago. It is not a big shop, employing less than one hundred, all told. It was a prosperous business a quarter of a century ago, and it was growing; its prosperity has not deserted it in all these years, but there has been little, if any, growth.

In talking with the superintendent, compressed air was mentioned and the multiplicity and variety of its uses in these days referred to. It then appeared that this shop has absolutely no compressed air in use, nor any means of supplying it. That, to the writer's mind, seemed to explain why the concern had not been growing. A shop needs compressed air in order to develop activity and push. The absence of compressed air implies the lack of other facilities of business which alert management—not necessarily "scientific"—brings together for the increase of efficiency and output.

Indeed, there is a single job in that shop which alone would pay for the installation and maintenance of a compressor, receiver, piping and all appurtenances. A single air hoist is all that would be required. There is a special machine built in considerable quantities which, in the assembling, makes necessary the hoisting of two or three rather heavy pieces. In the testing of these machines there are peculiar conditions which make it necessary to take each machine apart and put it together two or three times. Consider what it means to do the hoisting with a chain hoist and trolley on a short run of overhead track. The use of this hand-operated hoist necessitates an additional helper on the job, and it means also much slower movements for the hoisting and lowering operations. Then there are some large machine tools, a big planer, some big lathes, and a boring mill, but there are no air hoists for them—to say nothing of the pneumatic tools, hammers, drills, etc., which the shop would have use for, and the special applications of compressed air which would inevitably develop if the air was handy.

Without going into figures in detail, one dollar a day would liberally cover the interest upon the cost of installation, the maintenance, and the power cost of operating a compressed-air equipment for such a machine shop as has been mentioned. Where is the shop that can afford not to spend the dollar? There is absolutely not the slightest suggestion of experiment in the matter, as the value of compressed air as a shop cost reducer has been demonstrated wherever it has been employed. Its record in this respect is unique. No one has ever heard of any shop once adopting the use of compressed air and afterwards discarding it.

There are, in fact, comparatively few shops now which have not an air compressor as part of the equipment, and where any such shops are found, they are not railroad shops, because in these the handy airbrake pumps, which are far from ideal for general shop use, have provided an opportunity for "sampling" the compressed air service. The railroad shops are, therefore, now among the best customers of the builders of air compressors. Many machine-tool builders assume that there is always a supply of compressed air in the machine shop and design tools with air-actuated movements, thus increasing the efficiency and speed of operation. The shop without compressed air, and the manager who does not believe in compressed air, are shut off from the use of these improved tools. Compressors are now on the market with unlimited range of capacities, adapted to any mode of driving, entirely automatic, and working with all possible economy of power. In urging their wider employment, the writer aims to promote the interest of the machine-shop proprietor more than that of the compressor builder.

* Address: 229 W. 135th St., New York City.

LAYING OUT PROPELLERS*

By OLAF MALVIG†

In the following article is explained a method of laying out propellers which the writer has used at the works of the Trondhjems mekaniske Vaerksted for the last six years. The method has been found very satisfactory, both in the drawing office and in the foundry. Of course any method for developing a screw-thread surface on a plane surface is inexact, but the method explained has been found sufficiently accurate for all practical requirements. Figs. 1 to 3 show the method of laying out the propeller in the drafting-room; Fig. 4 shows an adjustable guide-curve device used for molding propellers; while Fig. 5 shows the details of this device. The guide-curve device has been in use at the works mentioned for the last two years, and has proved very satisfactory as a saver of both time and material. The halftone shows a model guide-curve device, 9 inches long, placed beside a wooden model which represents the propeller mold, and which is marked off from the propeller drawing. Fig. 5 gives the main dimensions for a full-sized device in use in the works. The guide-curve can be adjusted, ready for use, in from 10 to 15 minutes.

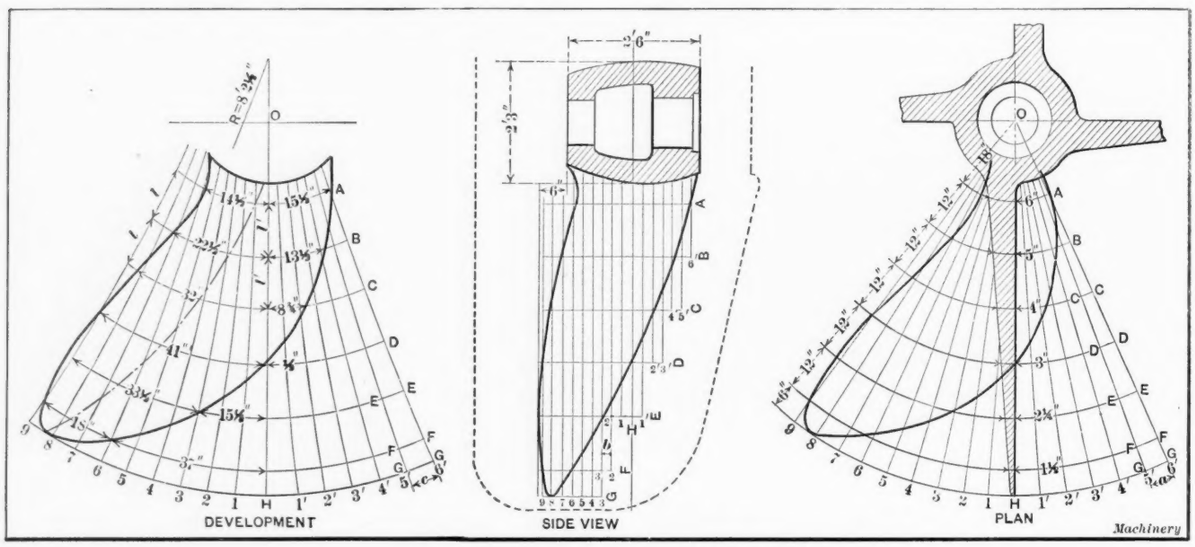
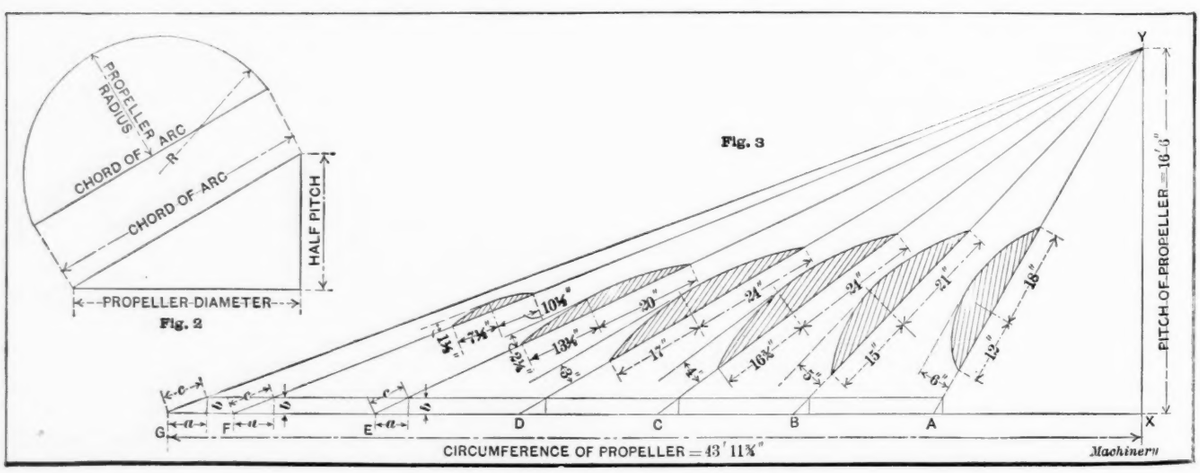


Fig. 1. Development, Side View and Plan of Propeller

The method of laying out the propellers and the use of the guide-curve device can be best explained by reference to a specific example. The dimensions of the propeller to be laid out are supposed to be known. In this case, the diameter is 14 feet, the pitch is 16 feet 6 inches, and the area of the developed surface of the blade 61 square feet. The back-throw abaft the propeller hub is 6 inches.

In the plan, as shown in Fig. 1, first draw a section of the blade and the hub; then draw an arc of a circle *G*, passing through the tip of the blade. Mark off on the radius *OG* any number of points *A*, *B*, *C*, etc., and draw arcs through these points with *O* as a center. On arc *G* set off any number of equal distances 1, 2, 3, etc., and 1′, 2′, 3′, etc., on each side of the center line *OH*, and draw radial lines from the points thus set off. In the present case each of the divisions on arc *G* is 6 inches.

Lay off to any convenient scale the horizontal line *GX*, Fig. 3, which represents the circumference of the propeller at the tips of the blades, and let the distances *AX*, *BX*, *CX*, etc., represent the circumference at points *A*, *B*, *C*, etc., in the plan, Fig. 1. The vertical line *XY*, Fig. 3, represents the pitch of the propeller. Join the points *A*, *B*, *C*, etc., with the point *Y* as shown. These lines show the angle of the propeller blade sections. In the side view, Fig. 1, draw the longitudinal section of the propeller hub and the propeller aperture. The hub must be placed in its proper position in the aperture so that the exact clearance of the propeller can be seen. The aperture is indicated by dotted lines. Also divide the space for the side view of the blade, by vertical lines, into a number of equal spaces corresponding in number to the divisions in the plan.



Figs. 2 and 3. Method of Laying Out Propellers

Set off on the base line at *G*, Fig. 3, any one of the distances on arc *G*, Fig. 1. In the present case, assume that the distance *a* in the plan is transferred as indicated. Distances *b*, Fig. 3, are equal to any of the distances *H*–1, 1–2, 2–3, etc., in the side view. As the propeller has a uniform pitch, the

* For further information on this and kindred subjects, see MACHINERY, November, 1908, "A Propeller Planing Machine;" November, 1907, "Obtaining the Pitch of a Propeller;" September, 1907, "Laying Out a Propeller;" November, 1903, engineering edition, "Bauer Propeller Blade Shaping Machine;" October, 1903, "A Screw Propeller Planing Machine."

† Address: Gyldenloves gade, 11, Trondhjem, Norway.

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height b will be the same for all the small triangles shown at the base in Fig. 3. The base a of the seven small triangles, however, is equal to the distances FF, EE, DD, etc., on the arcs F, E, D, etc., in the plan view. The hypotenuse c in each of the small triangles is now equal to the distances GG, FF, EE, etc., in the development in Fig. 1.

Next calculate the radius of arc G in the development. As is well known, the radius in the development view will not

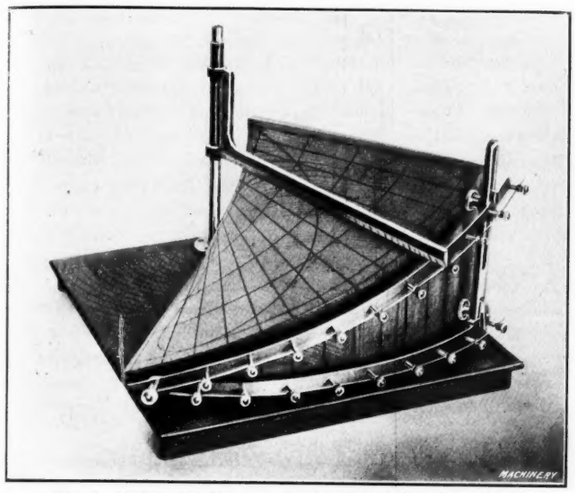

Fig. 4. Model of Guide-curve Device for Molding Propellers

be the same for two propellers of equal diameters if they do not have the same pitch. The easiest way to determine this radius is as follows: Draw a triangle, as shown in Fig. 2, where the base equals the diameter of the propeller, and the height equals one-half the pitch. The hypotenuse of this triangle will then be equal to the chord of an arc, the versed sine of which equals the radius of the propeller, and the radius of which equals the radius of arc G in the development.

The formulas for the calculation of the radius G of the development are as follows (see Fig. 2):

Let C = chord of arc,

D = diameter of propeller,

P = pitch of propeller,

R = radius of development of propeller blade surface.

Then

$$C = \sqrt{D^2 + (\tfrac{1}{2}P)^2}$$

$$R = \frac{(\tfrac{1}{2}C)^2 + (\tfrac{1}{2}D)^2}{D}$$

The radii for arcs A, B, C, etc., in the development, Fig. 1, are determined in a similar manner. In the development, the same center can be used for all seven arcs if the pitch is small, but for large pitches, it is necessary to move the center upwards for the smaller arcs, otherwise the distances 1 will be somewhat longer than distances 1′, as the lines in the development are not radial. Set off a sufficient number of distances 1, 2, 3, etc., and 1′, 2′, 3′, etc., on both sides of the center line OH in the development. Set off on the arcs A, B, C, etc., the distances c as found from Fig. 3, c being the hypotenuse of the seven small triangles, as already explained. Through the points thus determined draw slightly curved lines which represent the radial lines in the plan and the vertical lines in the side view. Then, in the development sketch in, by free hand, the propeller blade to about the required shape, and measure the area by a planimeter. Small alterations may have to be made in order to get the right area.

On the radial lines in the plan and the vertical lines in the side view, mark off the points where the contour of the blade crosses the radial lines in the development, and then, by free hand, sketch in the contour of the blade through these points, so as to get the shape of the blade in the plan and side view. It must be remembered that the shape of the blade in the side view is not what it would appear to the eye, but is the exact opening required for the blade when revolving. The curve of the propeller hub in the development is found by taking the vertical distances between the horizontal line A and the propeller hub in the side view.

The use of the guide-curve for laying out propeller blades in the foundry from the drawings will be apparent from the illustration of the device itself.

* * *

RECORD OF AUTOMATIC SPRINKLERS

The development of concrete and hollow tile building construction, with the attendant development of means of limiting fires to restricted areas, such as fire walls, automatic self-closing doors and windows, etc., have made it possible to construct buildings which can be relied upon to resist fire to a very great extent. In the ordinary case, however, the same measure of protection has not been afforded the contents of the building, and we occasionally see a structure which is considered absolutely fireproof, but which has been completely gutted, and left with simply bare walls. The development of automatic sprinklers has reached such a point, however, as to make it possible to give the contents of a fireproof building the very highest degree of protection, and to insure that whatever fire may start from spontaneous combustion, or any other source, will be confined to a very limited area, and in most cases entirely extinguished without human aid. The record of the automatic sprinkler is already absolutely clear so far as preventing the spread of fires is concerned. In 1911, 96.6 per cent of all fires under sprinklers were absolutely prevented from spreading, and most of the failures were due to the fact that the apparatus had been tampered with.

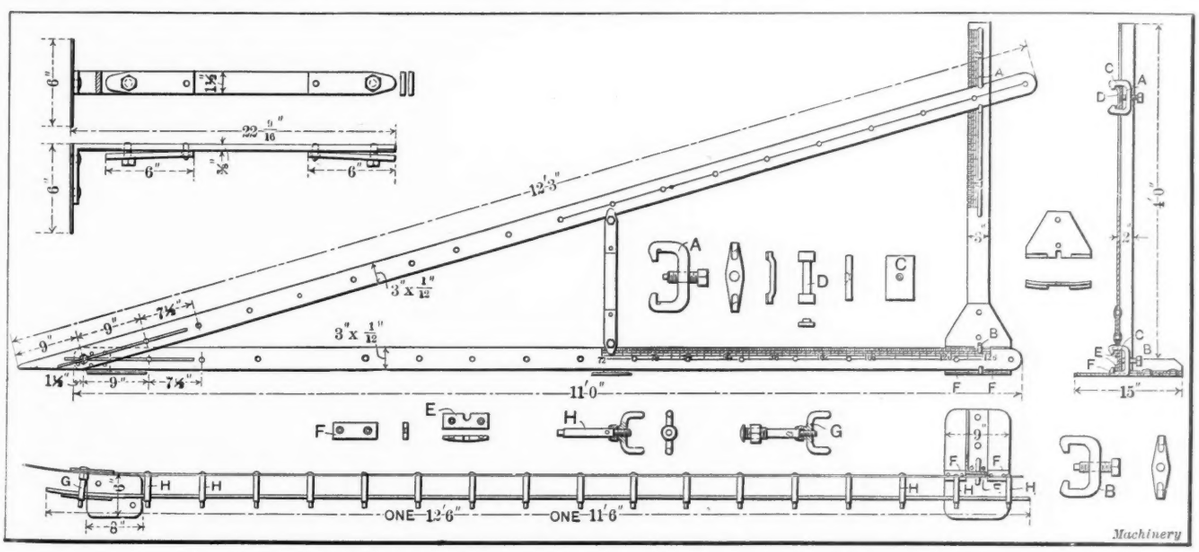

Fig. 5. Details of Full-size Device made on Same Principle as that illustrated in Fig. 4

PRESSURE OF COAL ON STORAGE BIN WALLS*

When designing storage bins for coal or other material of similar nature, the first factor to be determined is the pressure of the coal against the retaining walls. Owing to the fact that there is a certain amount of friction between the individual pieces of coal, this pressure cannot be considered or calculated the same as would the pressure of water or any other fluid contained in a bin or reservoir.

If coal is stored on a floor or other horizontal surface in a pile not constrained at the sides, it will assume a cone shape as indicated in Fig. 1. The angle which the sides of the cone form with a horizontal plane depends upon the kind of coal stored and, to some extent, upon the size of the coal. "The angle of repose" is then the angle which a pile of coal will assume when not constrained by retaining walls. For anthracite coal it may be assumed to have an average value of 27 degrees and for bituminous coal an average value of 35 degrees.

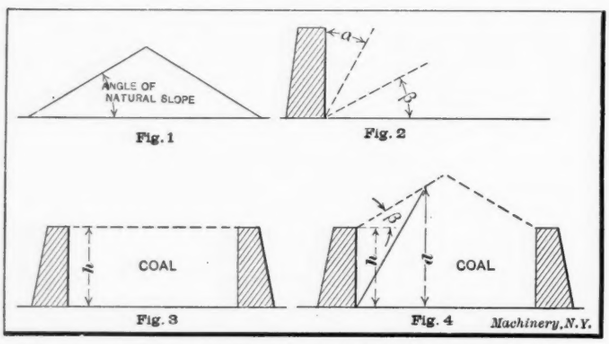

Fig. 1 Fig. 2 Fig. 3 Fig. 4

Figs. 1 to 4. Angles used in Formulas for Calculating Pressure on Storage Bin Walls, and Different Methods of Storing Coal

This angle is the basis of the calculation of the horizontal pressure upon the walls exerted by coal contained in a storage bin.

In the formula for calculating the horizontal pressure on the retaining wall per foot of length, the angle a, Fig. 2, is used. This angle is one-half of the angle which the line of repose or natural slope line makes with the vertical, hence:

$$a = \frac{90^\circ - \beta}{2}$$

β being the angle of repose. In the case of anthracite coal we then have:

$$a = \frac{90^\circ - 27^\circ}{2} = 31 \text{ degrees } 30 \text{ minutes},$$

and in the case of bituminous coal:

$$a = \frac{90^\circ - 35^\circ}{2} = 27 \text{ degrees } 30 \text{ minutes}.$$

Coal can be stored in a bin either with the top surface horizontal, as shown in Fig. 3, or with the top surface cone-shaped, as shown in Fig. 4. The pressure upon the retaining wall evidently is greater in the cases shown in Fig. 4 than in that shown in Fig. 3. The formula for the total pressure on the retaining wall per foot of length for a bin containing coal with the surface horizontal, as shown in Fig. 3, is:

$$P = \frac{wh^2}{2} \tan^2 a$$

in which

P = total pressure per foot of length on retaining wall, in pounds,

w = weight of coal per cubic foot, in pounds,

h = height of retaining wall, in feet,

a = angle as shown in Fig. 2 = 31 degrees 30 minutes for anthracite coal, and 27 degrees 30 minutes for bituminous coal.

The weight w per cubic foot may be assumed as 52 pounds for anthracite coal and 47 pounds for bituminous coal.

The pressure upon the retaining wall when the coal is stored as indicated in Fig. 4, is obtained by the same formula as that used for bins with the coal surface horizontal except that instead of the factor h^2 in the formula, a value equal to 1.454 h^2 for anthracite coal, and a value equal to 1.574 h^2 for bituminous coal is used. The formula then is:

$$P = \frac{w \times 1.454\, h^2}{2} \tan 31^\circ\ 30' \text{ for anthracite coal, and}$$

$$P = \frac{w \times 1.574\, h^2}{2} \tan 27^\circ\ 30' \text{ for bituminous coal.}$$

The constants 1.454 and 1.574 express the ratios between d and h in Fig. 4 for anthracite and bituminous coal, respectively. These ratios can be applied directly only when the angles of slope remain 27 and 35 degrees, respectively.

The tables in the accompanying Data Sheet Supplement have been calculated by means of the formulas given. The column giving the pressure on the lowest foot is obtained by subtracting the total pressure for a wall one foot lower in height, from the total pressure for the wall under consideration. For example, if the pressure on the lowest foot of a wall 10 feet high is to be calculated, subtract the total pressure for a 9-foot wall from the total pressure for a 10-foot wall. Hence, for anthracite coal with the surface horizontal:

$$978 - 792 = 186 \text{ pounds},$$

which value, it will be found, agrees with that given in the accompanying Data Sheet Supplement.

* With Data Sheet Supplement.

* * *

MULTIPLICATION TABLE FOR RIVET SPACING*

It is well known that the most tedious and difficult mathematical operation is simple addition. Hardly anyone but a trained accountant can add a column of figures and be sure the result is correct with the first trial. When the numbers include fractions the difficulty of accurately adding them is greatly increased. It follows, then, that in laying out a series of rivet holes for chain riveting, great care must be taken to avoid serious mistakes, especially when the spacing is expressed in fractions of an inch and there are several holes. Considerable time is required to accurately determine a series of spacings, and it is, therefore, highly important to have convenient means for facilitating the work of the draftsman and checkers of the drawings. It is customary to provide multiplication tables of rivet spaces for the use of designers of bridges, structural steel work, and other classes of fabricated shapes. The tables given in the Data Sheet Supplement, are examples of rivet multiplication tables calculated for spaces ranging from 1⅛ inch to 5¾ inches, varying by eighths up to and including 2½ inches, and by fourths from 2½ inches up to and including 5¾ inches. The number of spaces runs from 1 to 30.

The use of the table is practically self-evident. For example, suppose that eight rivet holes, 1⅜ inch pitch, are to be laid out. In the table under 1⅜ we find the total distance 9⅝ inches opposite 7. The overall distance, center to center, of the first and eighth hole is, therefore, 9⅝ inches. Again find the overall distance, center to center, of 12 rivets, 1⅝ inch spacing. Under 1⅝ and opposite 11 we find the overall space to be 1 foot, 5⅞ inches.

* * *

An interesting departure intended to aid in equalizing the demand on the electric power station during most of the hours of the day, has been put in force in the town of Sköfde, Sweden, which receives its current from the Trollhättan hydro-electric power station. During the hours of daylight a rate of only 1.35 cent per K. W. hour is charged, while during the night hours the rate is 9.4 cents per K. W. hour. This duplex rate has been adopted in order to stimulate the use of electricity for power purposes and for household use, other than lighting, the electric current being used in that case during the hours of daylight when the cheaper rate is in force. The consular report from which this information is obtained does not state what provisions are made for metering the current used at the various hours of the day.

* With Data Sheet Supplement.

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SHARPENING MILLING CUTTERS

By F. B. JACOBS*

Who has not read of the marvelous results attained by the manufacturers of milling machines, as set forth in their advertisements in the leading trade papers? These test records are, of course, made under the most favorable conditions, on new machines with new cutters and arbors, and under the supervision of men skilled in the art of teaching others how to cut down the cost of production. In everyday practice, where the conditions are not so favorable, it is impossible to duplicate the production records thus set forth. However, the

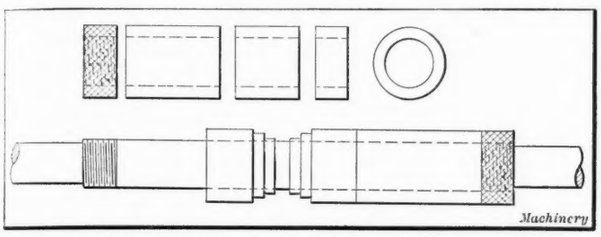


Fig. 1. Arbor and Sleeves used for Holding Cutter in Cutter Grinder

average shop superintendent can come closer than he does at present by looking more carefully after the milling cutters, arbors, etc.

Care of the Milling Machine

The spindle boxes should always be adjusted fairly close—so close, in fact, that they will warm up while using the machine on the highest speed with the back-gears out. A loose spindle causes chattering, inaccurate work, and various other troubles. Be sure that the taper hole in the spindle is free from scores and burrs. To insure this, take an ordinary milling machine arbor, place it between the centers of the lathe, and test it with an indicator to see that both the body and shank run true. Then place it in the milling machine and test again. If it does not run true, remove any scores or burrs that are in the taper hole with a scraper and test again. The chances are that the arbor will now run true; if not, the spindle is either sprung or worn out of round. In this case the machine should be given a thorough overhauling or consigned to the scrap heap, as it is the poorest kind of economy to try to attain accurate results with worn-out tools.

Short, stubby arbors should be used in preference to long ones when it is practical to do so, as a short arbor is not as easily sprung. If an arbor runs out more than 0.002 inch, the machine cannot be depended on to produce its maximum output. Before driving the arbor home, the operator should clean the hole in the spindle with a piece of waste and take the precaution to see that there are no burrs on the shank of the arbor; if there are, they should be removed by draw-filing with a medium fine file.

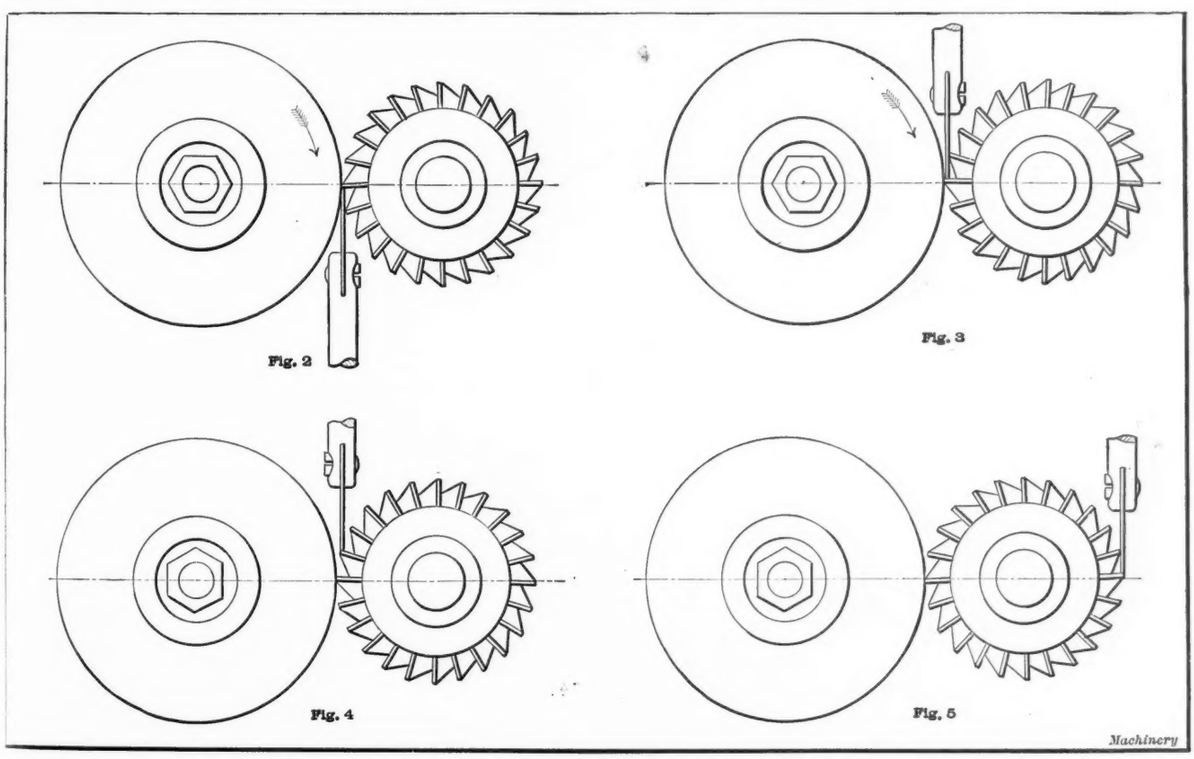
Milling Cutters

Milling cutters, for some reason, seem to receive very little care. Go into any machine shop and listen to the milling cutters at work; four or five teeth will be heard to take a very heavy cut, and then there will be an interval of silence until the spindle has made a revolution and brings the high teeth into the work again. This condition is caused by dirt in the taper of the spindle, burrs on the shank of the arbor, arbor out of true, cutter out of round, or a combination of all these evils. It causes a few teeth to do all the work, whereas if all of the teeth did their share of the work, this would mean longer life for the cutter and a better quality of the work turned out. End mills generally run out of true because they invariably are sprung in taking heavy cuts, and in re-sharpening they are nearly always located from the centers instead of from the shank, as they should be.

Cutter Sharpening

While the sharpening of milling cutters does not call for special skill or the services of a toolmaker, great care should be exercised in the selection of the wheels for this purpose. Wheels for cutter sharpening should be of a medium soft grade and not too fine—never finer than 60 grit. Fine wheels cut slowly and will burn the teeth unless the operator is very careful. Wheels for sharpening cutters made of high-speed steel can be a little coarser than those used on carbon steel. It is well to have two sets of wheels and use each for the purpose intended.

It should be remembered that the softer a wheel is, the faster it will cut; but if the wheel is too soft, it will wear away rapidly, which makes it difficult to keep the cutter round while sharpening it. This difficulty can be overcome by using a wider wheel, above ¾ inch, instead of the ⅜- or ½-inch wheels commonly used. A wide soft wheel will last as long as a narrow one in a harder grade, and being of a softer



Figs. 2 and 3. Correct Position of Guide Finger. Figs. 4 and 5. Incorrect Position of Guide Finger

* Address: Care of The Carborundum Co., Niagara Falls, N. Y.

grade, it tends to eliminate the danger of burning. For the sharpening of ordinary milling cutters a wide wheel will not be as inconvenient as it may seem, as there is generally plenty of room on each side of the wheel to pass the cutter.

The best way to hold ordinary milling cutters for sharpening is to mount them on a sleeve made for this purpose. (See Fig. 1.) These sleeves are used in many machine shops. They slide on a round bar held in the cutter grinder, and if the bar is straight, it is evident that the teeth of the cutter will be ground parallel. Cutters can, of course, be placed on an ordinary mandrel or arbor held between the centers of the cutter grinder. If this method is used it is well to be certain that the mandrel runs true and that the centers are

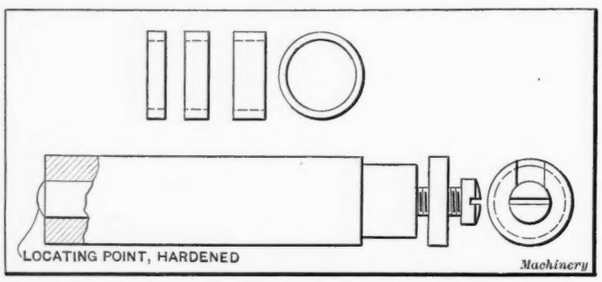


Fig. 6. Arbor used when Sharpening Side Teeth of Milling Cutters

in line with the ways of the machine, otherwise the teeth of the cutter will not be parallel. Since it takes a great deal of cutting and trying to determine this, it is best to use the other method when possible, as it is more rapid and reliable.

Cutters can be sharpened on the periphery of a disk wheel, as in Fig. 2, or on the side of a cup wheel. Some operators prefer to use a cup wheel for this purpose, because the periphery of a regular wheel leaves the teeth concave, thereby causing them to become dull sooner than they would if they were ground on the side of a cup wheel. However, if the wheel is not under three inches in diameter, it will not grind the teeth enough concave to cause trouble, and the disk wheel will do the work quicker.

The wheel may be run with relation to the tooth as shown in Fig. 2, or in the opposite direction, as shown in Fig. 3. It

Fig. 7. Sharpening Side Milling Cutters

is considered more convenient to run the wheel as in Fig. 2, as the pull of the wheel helps to hold the tooth firmly onto the guiding finger. Running the wheel in this direction throws up a burr on the edge of the tooth which should be removed by stoning. If the wheel is run as shown in Fig. 3, it will grind smoother and a heavier cut can be taken without so much danger of burning, but it must be remembered that the direction of rotation of the wheel has a tendency to pull the tooth away from the guiding finger. Therefore, care has to be exercised in holding the cutter in position, as any carelessness will result in a spoiled tooth and, sometimes, in a broken wheel. If the operator is inexperienced it is safer to run the wheel as in Fig. 2. With an experienced operator, however, more and better work can be produced by running the wheel the other way.

In sharpening, the teeth should be guided by a steel finger clamped close to the face, and enough off center to give the proper clearance. (See Fig. 3). Milling cutters need very little clearance; too much clearance invariably causes them to chatter and to soon become dull. It is hard to give any set rule for determining the amount of clearance, owing to varying shop conditions, but a clearance of five degrees is generally considered satisfactory. The guiding finger should always bear on the tooth that is being sharpened (see Figs. 2 and 3) instead of on one tooth below or on the other side of the cutter. While it is sometimes more convenient to locate the guiding finger one tooth below or on the other side of the cutter, this practice is often the cause of cutters hav-

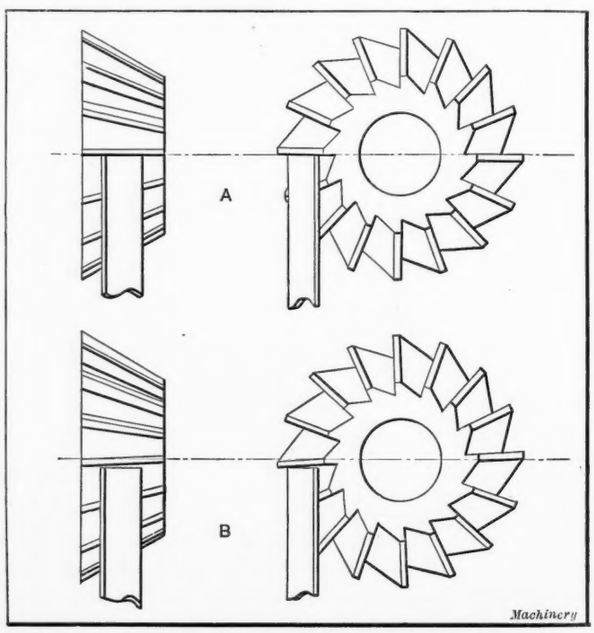


Fig. 8. (A) Correct and (B) Incorrect Positions of Guide Finger when Sharpening Angular Cutters

ing some of their teeth under the true cutting circle. Incorrect positions are shown in Figs. 4 and 5.

Care should be taken in keeping cutters round while sharpening them. The first tooth sharpened should be marked with chalk before starting, and each tooth should be moved past the wheel with a steady, but not necessarily slow, motion. Care should be taken not to remove too much stock at one cut; if crowded, the tendency will be to burn the work and cause the wheel to wear away too rapidly. The rapid wearing of the wheel will leave the cutter considerably out of round. Under favorable conditions a cut of 0.003 inch can be taken without burning the teeth or wearing the wheel away enough to cause the cutter to be out of round more than 0.001 inch. A slight error of this kind is corrected in the finishing cut. The operator should finish up with a light cut, say 0.001 inch deep, and before removing the cutter, he should make sure that it is round. This is easily determined by the manner in which the teeth "spark" on the wheel.

Sharpening End Mills

When re-sharpening, end mills should never be held between centers, even if it appears to be the easier way. They should always be located from the shank, because end mills are almost always out of true after having been used a few times, and for this reason the teeth cannot be brought concentric with the shank if the mill is held between centers. All makers of cutter grinders should provide suitable collets for this purpose to fit the swivel head of the machine.

The swivel head must be in line with the ways of the

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machine, otherwise the teeth will not be parallel with each other. The work should be calipered at both ends with a micrometer to make sure that it is straight. The same wheels can be used for this work that are used for sharpening ordinary milling cutters, and the process is much the same. In sharpening spiral mills or cutters, the operator should see that the guiding finger bears evenly on the tooth as otherwise it will be difficult to keep the teeth parallel.

Sharpening the Side Teeth

The side teeth of milling cutters require very little attention after they have been backed off when the cutter is new. They are generally sharpened by being held on a straight arbor with one end turned down so as to bring the cutter up to a shoulder. A screw and washer hold the cutter in position. (See Fig. 6.) In Fig. 7 the arbor for holding the cutter rests in a V in the cutter sharpening head which is set over to an angle of five degrees to give the proper clearance to the teeth.

The teeth are sharpened by feeding them past the face of a disk or cup wheel. A wheel for this purpose should be very free cutting; otherwise the teeth will be burned and thus ruined. As a general rule the side of a wheel is never as free cutting as the periphery, and for this reason the depth of cut should seldom be over 0.002 inch deep. It is best to run the wheel towards the edge of the tooth as this helps to overcome the danger of burning.

Angular Cutters

Angular cutters should be sharpened by placing them on a mandrel or arbor which will fit the swivel head of the cutter

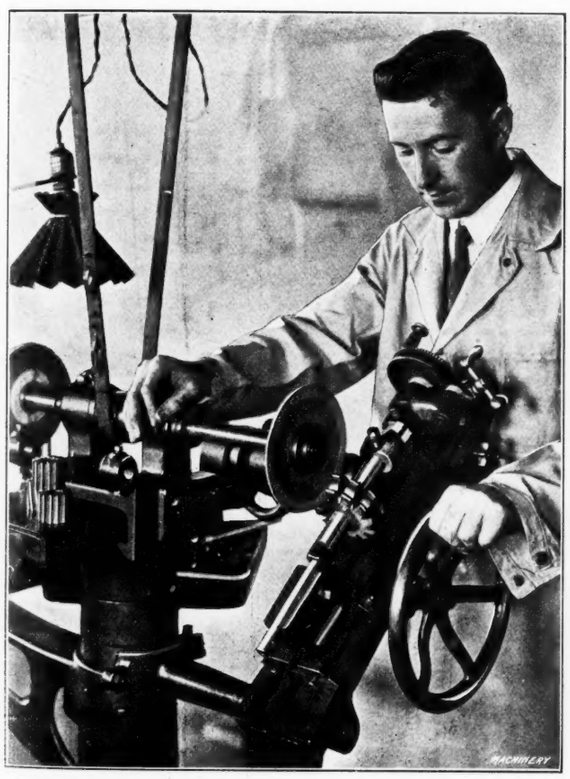

Fig. 9. Grinding Form Cutters, by means of a Form Cutter Grinding Attachment

grinder. The head should be set by its graduations to give the proper angle. In sharpening cutters of this kind, the guiding finger must be set exactly on the center, otherwise the proper angle cannot be maintained. The angle for clearance, in this case, is obtained by raising the wheel or lowering the swivel head, according to the design of the machine. In no case should the guiding finger be set below the center. Many machinists overlook this important point which is the cause of many angular cutters being inaccurate and unfit for close work. (See Fig. 8.)

Form Cutters

Form cutters are without doubt the most difficult cutters to sharpen properly, as all of the grinding has to be done on the side of a disk wheel. One way to sharpen form cutters is on a surface grinding machine, using for this purpose the dividing centers with which it is generally equipped. Another, and perhaps a more convenient way, is with a form cutter grinding attachment as shown in Fig. 9. The accurate spacing of the teeth must be maintained under all conditions, or else all of the teeth will not cut; and as form cutters have comparatively few teeth, it is best to have all of them in working condition. This makes it necessary to remove the same amount from each tooth (providing the spacing is accurate) every time the cutter is ground, regardless of whether all of the teeth are dull or not. If some of the teeth are dull and some sharp it may be caused by the

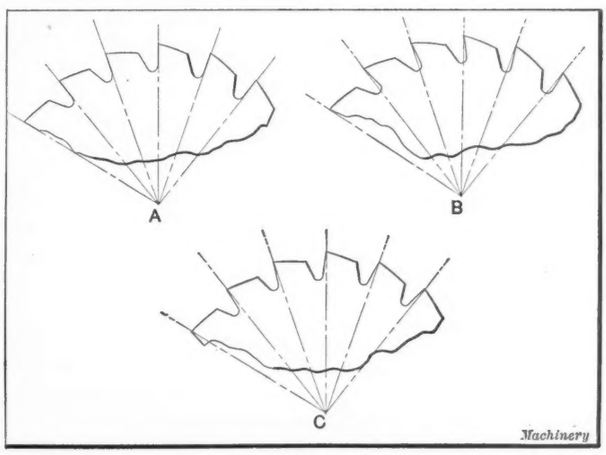

Fig. 10. Correct and Incorrect Methods of Grinding Form Cutters

teeth having been inaccurately spaced in a previous grinding operation, or it may be that the cutter has been used on an arbor that did not run true.

In setting up the grinder for this operation, the cutting side of the wheel should run true and should be directly in line with the centers. If the wheel is set off center, the cutter will not mill the shape that it was designed for. This is one of the first principles as regards form tools, and one that should be rigidly adhered to. A form cutter that has been sharpened off center will not mill the shape for which it was designed for the same reason that an ordinary thread tool will not cut a sixty degree thread if set above or below center.

After the wheel has been set, its position relative to the centers should not be disturbed. For this reason the work should be brought to the wheel by slightly adjusting the arm that carries the index pin. If the wheel has to be dressed during the grinding operation it should be set central again before proceeding with the work.

Each tooth should be ground evenly and carefully with a comparatively light cut, as a heavy cut will burn the teeth. The operator should bear in mind the fact that it takes time and patience to properly sharpen form cutters. Never under any circumstances should it be attempted to do the work by hand, as is sometimes done with gear cutters.

In Fig. 10 are shown some form-cutter teeth. The correct form of tooth, as shown at *A*, has its cutting face parallel with a line drawn from the center to the periphery of the cutter. Illustrations *B* and *C* show the so-called "hook" and "drag" teeth. As will be seen, the faces of these teeth are at an angle with a line drawn from the center to the periphery of the cutter. These teeth will not mill the shape for which the cutter was designed.

Truing Wheels

Wheels for cutter sharpening operations should run true to produce the best results, and should be dressed at the first sign of glazing; otherwise burned teeth will be the result. A diamond tool is generally used for this process, although a carborundum brick, 20 grit, H grade, which costs as many cents as a diamond does dollars, will be found to answer the purpose in a very satisfactory manner.

Wheels for Cutter Sharpening

Wheels for cutter sharpening should be properly taken care of and not thrown about at random to collect oil and dirt.

When not in use, they should be kept in a place by themselves with their grading tags tacked over them for reference. Following is a list of "Aloxite" wheels that the writer has used for cutter sharpening operations with excellent results. To give the best results the wheels should be run at a surface speed of 5000 feet per minute.

For carbon steel mills and cutters, 50 grit, O grade, D496 bond.

For high-speed steel mills and cutters, 40 grit, O grade, D496 bond.

For carbon steel form cutters, 50 grit, P grade, D495 bond.

For high-speed steel form cutters, 40 grit, P grade, D495 bond.

These grits, grades and bonds will be found satisfactory in nearly every case. If the operator meets with any difficulties that he cannot overcome, he should not hesitate to take up the matter with the wheel manufacturers.

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DESIGNING ENGINEERS ON STRIKE

In the September, 1910, number of MACHINERY reference was made to the unfavorable conditions under which technically trained men in Germany work. These conditions have caused German engineers, designers and others with technical training to combine into societies similar to trade unions, one of which now has 17,500 members and another 29,500 members. One of these societies has now begun to take active steps to improve the conditions of the members, following closely the methods of the trade unions. Since October 1, about 250 engineers and designers, including nearly ninety per cent of all those employed in the structural steel branch in Berlin are on strike. The main requirements of the striking engineers are as follows: An eight-hour day with one-half hour's allowance for lunch, and six hours Saturday; over-time to be paid at the rate of 1/200 of the monthly salary plus thirty per cent; vacations with pay to be allowed—ten days after six months' service, two weeks after one year's service, and two days additional for each year until the vacation period amounts to three weeks; wages to be paid in case of performance of military duty not exceeding eight weeks; inventions to be the property of the inventor. The employers, not willing to accept these conditions, have made the following propositions: A straight eight-hour day, exclusive of lunch hour; eight hours over-time per month without compensation; over-time above this limit to be paid at the hourly rate plus twenty per cent; vacations to be given only after one year's full service; length of vacation to be one week during the first three years and later two weeks; in case of military service full pay for two weeks if the employe has been employed a full year; employes who have been in the firm's employ a considerable time (exact time not stated) are, in addition, entitled to half pay for a period not exceeding a total of eight weeks; all invention to be the property of the employer; any paid employment after hours, or any public office of trust, can be engaged in or held only after written permission has been obtained from the firm. The engineers consider these conditions impossible of acceptance. In other parts of Germany the employers have already begun to break up the organizations of the engineers and designers by aggressive methods.

* * *

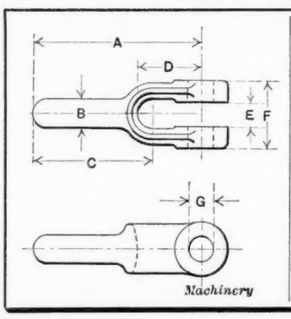
VANALIUM

Aluminum alloys, alleged to have the strength, ductility and other characteristics of steel are becoming very numerous. The *Railway Engineer* (London) tells of a new and remarkable alloy which has been brought out in Great Britain and which is supplied at a price of from thirty-two to thirty-six cents a pound. It has the lightness of aluminum, the ease in working of gun metal, and a stiffness and tensile strength approaching that of wrought iron and mild steel. It can easily be cast, forged, rolled into sheets, spun and drawn into tubes, rods and wire. When cast, it is not brittle like cast iron. The tensile strength is over 22,000 pounds per square inch, with six per cent elongation. Drawn vanalium will withstand a tensile stress of up to 66,000 pounds per square inch. The color of the metal is white and it takes a high polish. Its melting point is about 1200 degrees F.

STANDARD YOKE AND EYE-ROD ENDS FOR AUTOMOBILES

In the Data Sheet Supplement of the October, 1909, number of MACHINERY, were given tables of standard yoke and eye-rod ends, as adopted by the Association of Licensed Automobile Manufacturers, known as the A. L. A. M. standards.

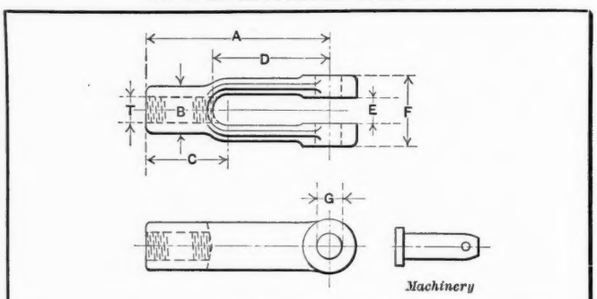
TABLE I. PLAIN YOKE ENDS



A	B	C	D	E	F	G
1¼	3/16	7/8	7/16	3/16	7/16	3/16
1⅜	1/4	1 1/4	5/8	9/32	5/8	1/4
2	5/16	1 3/8	3/4	11/32	3/4	5/16
2⅛	3/8	1 7/16	27/32	7/16	7/8	3/8
2¼	7/16	1 1/2	1	1/2	1	7/16
2½	1/2	1 5/8	1 1/8	9/16	1 1/8	1/2

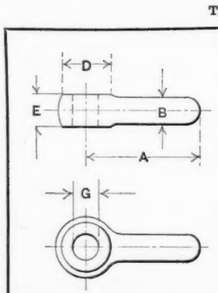
The Society of Automobile Engineers is now issuing leaflets giving the mechanical standards recommended by its professional committees and accepted by the society. This body of engineers is the custodian of the standards formerly established by the Association of Licensed Automobile Manufacturers. One of the standards formerly established, which has proved less successful, was that for the yoke and eye-rod ends, and the new society has therefore adopted a new set of standards to supersede those previously agreed upon. The scope of the standards has been somewhat increased, the general design has been improved, and the dimensions of the various parts have been changed to better meet the results of the experience during the last years. The accompanying tables give the dimensions as now definitely adopted. All the considerations involved have received adequate study.

TABLE II. ADJUSTABLE YOKE ENDS



A	B	C	D	E	F	G	T
1 9/16	5/16	11/16	1	3/16	7/16	3/16	3/16 32 U. S.
2	7/16	7/8	1 1/4	9/32	5/8	1/4	1/4 28 A.L.A.M.
2 1/4	1/2	1	1 7/16	11/32	3/4	5/16	5/16 24 A.L.A.M.
2 1/2	5/8	1 1/8	1 5/8	7/16	7/8	3/8	3/8 24 A.L.A.M.
2 7/8	23/32	1 1/4	1 7/8	1/2	1	7/16	7/16 20 A.L.A.M.
3	13/16	1 7/16	1 7/8	9/16	1 1/8	1/2	1/2 20 A.L.A.M.

TABLE III. ROD ENDS



A	B	D	E	G
1¼	3/16	3/8	3/16	3/16
1¼	1/4	1/2	9/32	1/4
1⅜	5/16	19/32	11/32	5/16
1½	3/8	11/16	7/16	3/8
1½	7/16	13/16	1/2	7/16
1⅝	1/2	15/16	9/16	1/2

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POINTS IN THE DESIGN OF TWO-STROKE CYCLE ENGINES*

By S. M. HOWELL†

The fact that a large proportion of the gas engines patented within the past decade provide a power impulse at each revolution of the shaft would seem to indicate that the general effort is in the direction of the two-stroke cycle principle; but it is plainly evident that very few of these proposed improvements have found favor with practical designers, and that the two-stroke cycle engine of today is almost the same as originally invented by L. H. Nash some twenty-three years ago, and improved by Shonlein, who took out his Swiss patent in 1891.

Nash was probably the originator of the closed crank-case, since universally adopted, by which the shaft end of the cylinder is used as a pump to force in the air charge. His engine, however, was deficient on account of its tendency to back-fire, and Shonlein to a great extent remedied this defect of the Nash engine by so locating the ports that the exhaust opened in advance of the admission, thus allowing the former free exit, reducing the heat, and relieving the back pressure against the incoming charge. He also discarded the crank-case check valve formerly used, and substituted a third port, operated by the piston, thus completing the so-called three-port engine. Nash was not oblivious of the defect of his engine, and must have recognized the cause, but strangely enough failed to devise the simple expedient by which Shonlein afterward so easily remedied the trouble.

Many of the attempts which have later been made to effect further improvements by the use of additional parts,

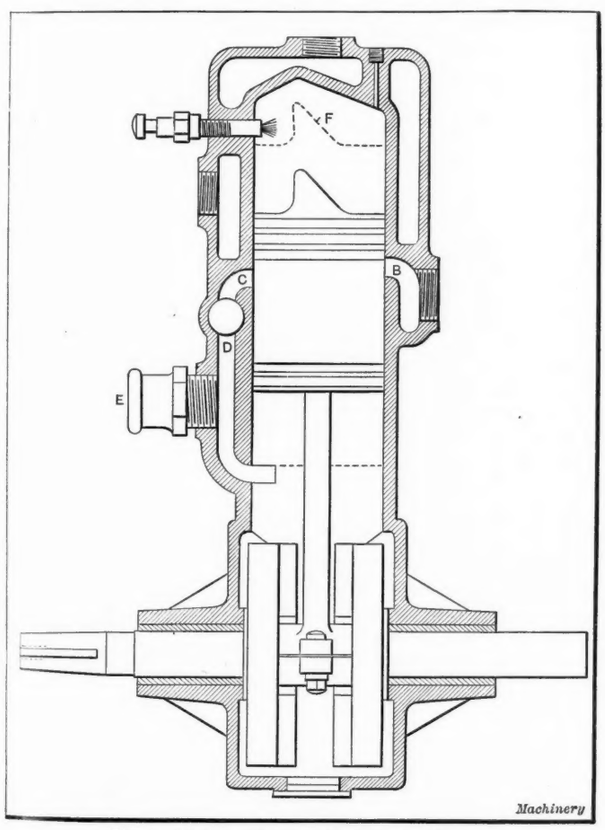
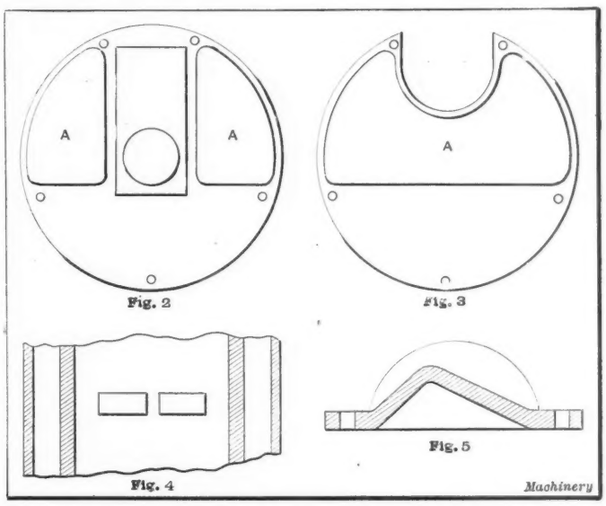


Fig. 1. Section of Two-stroke Cycle Gas Engine

have fallen short of commercial success for the reason that one of the chief merits of the two-stroke cycle engine is its mechanical simplicity. With good design, and attention to certain details, a satisfactory engine may be secured without such additions, and with only slight modifications of some of the usual accessories.

Principles of Satisfactory Design

The reciprocating parts should be counterbalanced as nearly as possible, and the crank-case pressure should be as high as can be readily secured. Both of these important objects may be attained by the use of crank disks of suitable design. The piston deflector should be rather high, with the cylinder head shaped to accommodate it. With this construction the engine will run without undue vibration, and the



Figs. 2 and 3. The Two Parts of the Disks enclosing the Crankshaft Arms. Fig. 4. View showing Bridge across Inlet and Exhaust Ports. Fig. 5. Cylinder Head for Oil Engines

cylinder will receive a strong charge before which the burnt gases will be driven out without mixing to any great extent with the fresh gas, so that there will be no serious loss of fuel at the exhaust port.

The igniter should be located on the inlet side of the combustion chamber, in such a position that it will be within the enclosure formed by the deflector and the cylinder wall, when the piston is at the beginning of the power stroke. This space is always filled at the moment of the spark with fresh mixture, which will promptly ignite, no matter how small the charge may be; and this will enable the engine to run regularly, without missing impulses, even at slow speeds with light charges.

The throttle may be placed in the transfer passage, or it should in all events be so situated that the speed or power output may be regulated within wide limits of variation, without disturbing the relative adjustment of air and fuel at the initial intake. The quality of the mixture will then remain practically uniform at all times, while the quantity of fuel used will be proportionate to the development of power. The transfer passage should also contain a screen of wire cloth, or a perforated metal plate, to further provide against back-firing.

The initial intake or crank-case admission may be either the third port, as used by Shonlein, or a check valve. Many recent designers have shown a preference for the latter, and to this extent have reverted to the original practice of Nash. The fact is that in some cases the third port comes in an inconvenient place, and cuts up the cylinder in an undesirable manner. A valve, if used, must be of sufficient size and of light construction, made preferably of aluminum, and operating as nearly as possible without friction. These conditions are easily secured, as the valve works only in cold air, and the pressure will not exceed 10 pounds per square inch at the most. When using gasoline fuel, this valve conjoined to a float chamber with a delivery nozzle constitutes the carbureter.

Examples of Two-stroke Cycle Engine Design

In order to illustrate these principles of design, the accompanying engravings of a vertical two-stroke cycle engine of

* For additional information on this and kindred subjects, see the following articles previously published in MACHINERY: "Flywheels for Internal Combustion Engines," November, 1910, engineering edition; "Cooling Gas Engines," October, 1910, engineering edition; "Clearance Space of Gas Engine Cylinders," July, 1910; "Commercial Ratings for Internal Combustion Engines," "The Calculation of Crankshafts for Internal Combustion Engines," "Light and Reliable Gas Engines," "Carbureters and Vaporizers," and "Suggestions in the Design of Aeronautic Motors," all in April, 1910, engineering edition. See also the articles referred to in foot-notes in connection with the articles in the April, 1910, number, and MACHINERY'S Reference Book No. 65, "Formulas and Constants for Gas Engine Design."

† Address: Oroville, Cal.

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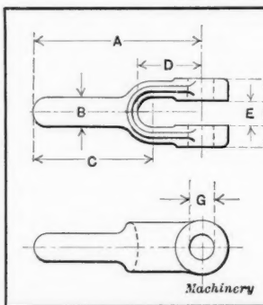
VANALIUM

Aluminum alloys, alleged to have the strength, ductility and other characteristics of steel are becoming very numerous. The *Railway Engineer* (London) tells of a new and remarkable alloy which has been brought out in Great Britain and which is supplied at a price of from thirty-two to thirty-six cents a pound. It has the lightness of aluminum, the ease in working of gun metal, and a stiffness and tensile strength approaching that of wrought iron and mild steel. It can easily be cast, forged, rolled into sheets, spun and drawn into tubes, rods and wire. When cast, it is not brittle like cast iron. The tensile strength is over 22,000 pounds per square inch, with six per cent elongation. Drawn vanalium will withstand a tensile stress of up to 66,000 pounds per square inch. The color of the metal is white and it takes a high polish. Its melting point is about 1200 degrees F.

STANDARD YOKE AND EYE-ROD ENDS FOR AUTOMOBILES

In the Data Sheet Supplement of the October, 1909, number of MACHINERY, were given tables of standard yoke and eye-rod ends, as adopted by the Association of Licensed Automobile Manufacturers, known as the A. L. A. M. standards.

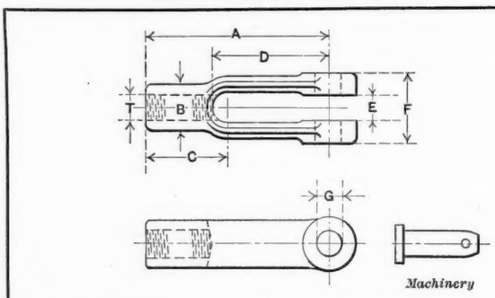
TABLE I. PLAIN YOKE ENDS



A	B	C	D	E	F	G
1 1/4	3/16	7/8	7/16	3/16	7/16	3/16
1 3/4	1/4	1 1/4	5/8	9/32	5/8	1/4
2	5/16	1 3/8	3/4	11/32	3/4	5/16
2 1/8	3/8	1 7/16	27/32	7/16	7/8	3/8
2 1/4	7/16	1 1/2	1	1/2	1	7/16
2 1/2	1/2	1 5/8	1 1/8	9/16	1 1/8	1/2

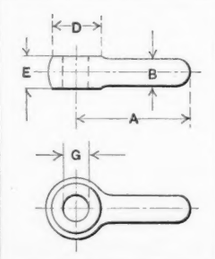
The Society of Automobile Engineers is now issuing leaflets giving the mechanical standards recommended by its professional committees and accepted by the society. This body of engineers is the custodian of the standards formerly established by the Association of Licensed Automobile Manufacturers. One of the standards formerly established, which has proved less successful, was that for the yoke and eye-rod ends, and the new society has therefore adopted a new set of standards to supersede those previously agreed upon. The scope of the standards has been somewhat increased, the general design has been improved, and the dimensions of the various parts have been changed to better meet the results of the experience during the last years. The accompanying tables give the dimensions as now definitely adopted. All the considerations involved have received adequate study.

TABLE II. ADJUSTABLE YOKE ENDS



A	B	C	D	E	F	G	T
1 9/16	5/16	1 1/16	1	3/16	7/16	3/16	32 3/16 U. S.
2	7/16	7/8	1 1/4	9/32	5/8	1/4	28 1/4 A.L.A.M.
2 1/4	1/2	1	1 7/16	11/32	3/4	5/16	24 5/16 A.L.A.M.
2 1/2	5/8	1 1/8	1 5/8	7/16	7/8	3/8	24 3/8 A.L.A.M.
2 7/8	23/32	1 1/4	1 7/8	1/2	1	7/16	20 7/16 A.L.A.M.
3	13/16	1 7/16	1 7/8	9/16	1 1/8	1/2	20 1/2 A.L.A.M.

TABLE III. ROD ENDS



A	B	D	E	G
1 1/4	3/16	3/8	3/16	3/16
1 1/4	1/4	1/2	9/32	1/4
1 3/8	5/16	19/32	11/32	5/16
1 1/2	3/8	11/16	7/16	3/8
1 1/2	7/16	13/16	1/2	7/16
1 3/4	1/2	15/16	9/16	1/2

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POINTS IN THE DESIGN OF TWO-STROKE CYCLE ENGINES*

By S. M. HOWELL†

The fact that a large proportion of the gas engines patented within the past decade provide a power impulse at each revolution of the shaft would seem to indicate that the general effort is in the direction of the two-stroke cycle principle; but it is plainly evident that very few of these proposed improvements have found favor with practical designers, and that the two-stroke cycle engine of today is almost the same as originally invented by L. H. Nash some twenty-three years ago, and improved by Shonlein, who took out his Swiss patent in 1891.

Nash was probably the originator of the closed crank-case, since universally adopted, by which the shaft end of the cylinder is used as a pump to force in the air charge. His engine, however, was deficient on account of its tendency to back-fire, and Shonlein to a great extent remedied this defect of the Nash engine by so locating the ports that the exhaust opened in advance of the admission, thus allowing the former free exit, reducing the heat, and relieving the back pressure against the incoming charge. He also discarded the crank-case check valve formerly used, and substituted a third port, operated by the piston, thus completing the so-called three-port engine. Nash was not oblivious of the defect of his engine, and must have recognized the cause, but strangely enough failed to devise the simple expedient by which Shonlein afterward so easily remedied the trouble.

Many of the attempts which have later been made to effect further improvements by the use of additional parts,

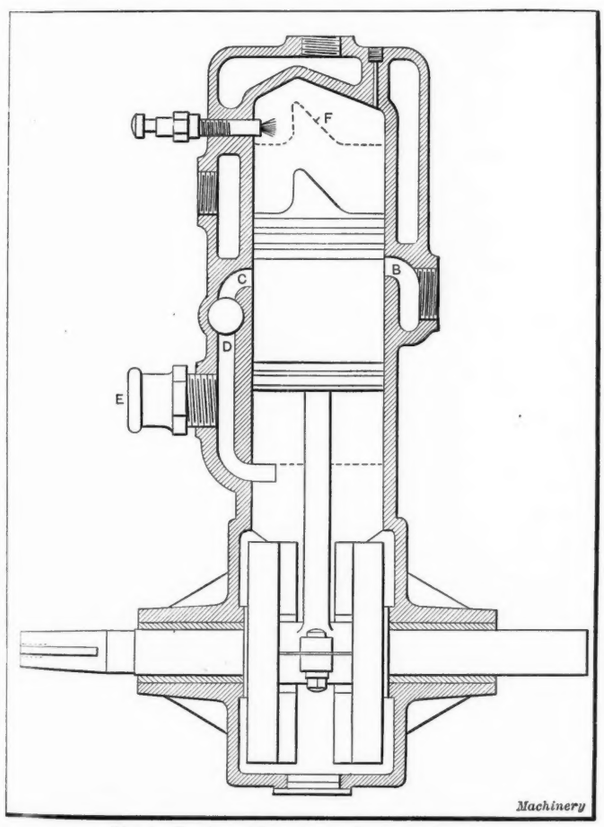
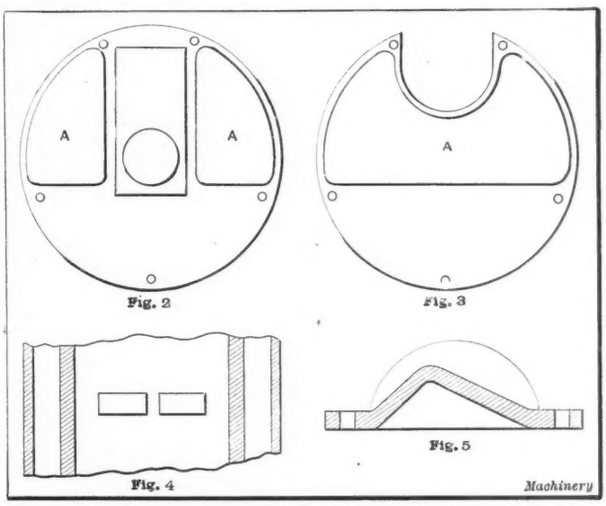


Fig. 1. Section of Two-stroke Cycle Gas Engine

have fallen short of commercial success for the reason that one of the chief merits of the two-stroke cycle engine is its mechanical simplicity. With good design, and attention to certain details, a satisfactory engine may be secured without such additions, and with only slight modifications of some of the usual accessories.

Principles of Satisfactory Design

The reciprocating parts should be counterbalanced as nearly as possible, and the crank-case pressure should be as high as can be readily secured. Both of these important objects may be attained by the use of crank disks of suitable design. The piston deflector should be rather high, with the cylinder head shaped to accommodate it. With this construction the engine will run without undue vibration, and the



Figs. 2 and 3. The Two Parts of the Disks enclosing the Crankshaft Arms. Fig. 4. View showing Bridge across Inlet and Exhaust Ports. Fig. 5. Cylinder Head for Oil Engines

cylinder will receive a strong charge before which the burnt gases will be driven out without mixing to any great extent with the fresh gas, so that there will be no serious loss of fuel at the exhaust port.

The igniter should be located on the inlet side of the combustion chamber, in such a position that it will be within the enclosure formed by the deflector and the cylinder wall, when the piston is at the beginning of the power stroke. This space is always filled at the moment of the spark with fresh mixture, which will promptly ignite, no matter how small the charge may be; and this will enable the engine to run regularly, without missing impulses, even at slow speeds with light charges.

The throttle may be placed in the transfer passage, or it should in all events be so situated that the speed or power output may be regulated within wide limits of variation, without disturbing the relative adjustment of air and fuel at the initial intake. The quality of the mixture will then remain practically uniform at all times, while the quantity of fuel used will be proportionate to the development of power. The transfer passage should also contain a screen of wire cloth, or a perforated metal plate, to further provide against back-firing.

The initial intake or crank-case admission may be either the third port, as used by Shonlein, or a check valve. Many recent designers have shown a preference for the latter, and to this extent have reverted to the original practice of Nash. The fact is that in some cases the third port comes in an inconvenient place, and cuts up the cylinder in an undesirable manner. A valve, if used, must be of sufficient size and of light construction, made preferably of aluminum, and operating as nearly as possible without friction. These conditions are easily secured, as the valve works only in cold air, and the pressure will not exceed 10 pounds per square inch at the most. When using gasoline fuel, this valve conjoined to a float chamber with a delivery nozzle constitutes the carbureter.

Examples of Two-stroke Cycle Engine Design

In order to illustrate these principles of design, the accompanying engravings of a vertical two-stroke cycle engine of

* For additional information on this and kindred subjects, see the following articles previously published in MACHINERY: "Flywheels for Internal Combustion Engines," November, 1910, engineering edition; "Cooling Gas Engines," October, 1910, engineering edition; "Clearance Space of Gas Engine Cylinders," July, 1910; "Commercial Ratings for Internal Combustion Engines," "The Calculation of Crankshafts for Internal Combustion Engines," "Light and Reliable Gas Engines," "Carbureters and Vaporizers," and "Suggestions in the Design of Aeronautic Motors," all in April, 1910, engineering edition. See also the articles referred to in foot-notes in connection with the articles in the April, 1910, number, and MACHINERY'S Reference Book No. 65, "Formulas and Constants for Gas Engine Design."

† Address: Oroville, Cal.

the valveless type, constructed upon the above lines, are shown. Fig. 1 is an assembled sectional view. This view shows the spark plug and the angular form of the interior head to accommodate the deflector. The dotted line *F* indicates the position of the piston at the beginning of the power stroke. The angular shape of the head also forms a deflecting surface which in conjunction with that of the piston materially aids in the expulsion of the burnt gases, by directing the fresh charge in a body to the top of the cylinder and then downward. This action largely prevents the mixing of the old and new charges. In Fig. 1, *B* is the exhaust port; *C*, the inlet port; *D*, the transfer passage; and *E*, the crank-case air valve or initial inlet.

The crankshaft is of the usual pattern, but the arms are enclosed in cast-iron disks made to fit over them, and including the necessary counterweights. For convenience in assembling, these disks are made in two parts as shown in Figs. 2 and 3. The hollow spaces *A* are tightly packed with asbestos board. When placed upon the crank arms, the two parts of each disk must be riveted together. These disks, in addition to furnishing the required counterbalance, greatly reduce the clearance of the crank-case, and thereby insure a high degree of initial pressure.

In designing small engines, the speed is usually assumed to be the highest of which the general design is capable in continuous service. Fixing this limit at 750 feet piston speed a minute, the exhaust port area should be one-eighth, and that of the inlet port three-thirty-seconds, of the piston area. These ports should be bridged by a narrow span of solid metal, as shown in Fig. 4. This makes two short openings in the cylinder wall in place of one, and permits the rings to pass smoothly over the ports. The ports should be so located that the exhaust will begin to open when the piston has completed four-fifths of its out-stroke, and should be about two-thirds open when the piston begins to uncover the inlet port, the latter being wide open when the piston has reached the extremity of its outward movement. This gives 80 per cent of the out-stroke to the direct production of power, and more than 30 per cent of the entire revolution for the exchange of the charges, with a lead of two-thirds the width of the exhaust port to clear the cylinder. This rule for port area may be modified somewhat to suit individual conditions, but it is about the usual practice, and the writer found it to be satisfactory in his own experience.

The piston clearance should be so proportioned that the compression will be about 80 pounds gage, or 95 pounds absolute, figured adiabatically. In four-stroke cycle designs the total displacement of the piston is used as the basis of this calculation, but in a two-stroke cycle engine, since compression can not begin before the closure of the exhaust, we must regard the displacement as the contents of the cylinder from the top of the exhaust port to the top line of the piston's travel. Then one-third of this amount will equal the required clearance, and the charge will be reduced to one-fourth of its atmospheric volume at a gage pressure of at least 80 pounds per square inch. Assuming the bore and stroke to be 4½ inches, the piston displacement above the exhaust port would be 57.3 and the clearance 19.1 cubic inches.

A single-cylinder engine thus designed, having a 16-inch flywheel with a 60-pound rim, should run steadily at a piston speed as low as 200 feet a minute, and is capable of a speed as high as 700 feet per minute, or even higher. The average power output should be as much as 0.00012 horsepower per cubic inch of total piston displacement per revolution per minute; or, in a 4½ by 4½ engine, 7 horsepower at a speed of a little over 800 feet per minute.

Changes Required for Oil Engines

The engine as shown in Fig. 1, and so far described, is designed to run on gasoline, drawn into the crank-case through the initial intake with the air; but, by a modification of the cylinder head, the addition of a special injecting device, and a change in the location of the throttle, kerosene distillate or any similar cheap product may be used as fuel. The oil fuel injector is a very ingenious device which has recently come into use, and has been successfully applied to several well-known makes of two-stroke cycle engines.

The principle of this device is as follows: Attached to the outside of the cylinder, adjacent to the inlet port, is a small float-feed cup, closed to the outer air, but connected at its upper part with the crank-case or transfer passage. The oil from the fuel tank is piped to this cup, into which it may flow by gravity, but is prevented from returning by a check or non-return valve, and from overflowing the cup by the action of the float upon a small valve in the usual well-known manner. A tube of small bore leads from the bottom of the feed cup through the cylinder wall, or the wall of the transfer passage, to a nozzle extending into the inlet port, almost into the bore of the cylinder. The area of discharging capacity of this fuel nozzle is controlled by a needle valve, the stem of which terminates in the usual handwheel, accessible from the outside. The adjustment of this valve, however, does not require frequent change. The crank-case handles air only, and the throttle is in the initial intake.

When the inlet port has been uncovered by the piston at the termination of the out-stroke and the beginning of the in-stroke, the pressure within the feed cup (received from the crank-case) forces a charge of the liquid fuel through the nozzle into the cylinder. The oil strikes the deflector and is caught by the entering air from the crank-case and carried upward to the top of the combustion chamber, where it comes in contact with a hot plate, or the heated surface of the cylinder head, and is thereby completely gasified. An interesting feature in the operation of this injector is the fact that it can deliver the fuel only in the interval of admission, that is, when the inlet port is open to receive the air charge. The reason for this is that while the inlet port is covered by the piston, the mouth of the oil nozzle is also in the zone of same pressure as that which is acting within the feed cup, and there is consequently no force to move the oil; but the instant the port opens, the tension at that point is relieved, and as the movement of the oil is parallel with that of the air current, it meets with no resistance.

The throttle consists merely of some means of controlling the lift of the initial intake valve. This, in stationary engines, is accomplished by the action of the governor. In boat engines, a small screw of coarse pitch, having a lever handle, may be arranged to bear upon the valve or its stem, and thus regulate the admission of air to the crank-case. The regulation of speed is effected solely by the manipulation of this throttle to reduce or increase the crank-case pressure; and since the quantity of oil ejected from the nozzle depends directly upon the pressure in the feed cup (and this is always equal to that of the crank-case), it follows that a change of air pressure by a movement of the throttle will be accompanied by a corresponding change in the amount of oil delivered, and the resulting mixture will be of same quality as before.

A modification of this device draws the oil into the feed cup by the vacuum of the crank-case when the piston rises, and this obviates the necessity of elevating the fuel tank above the engine. As an engine cannot easily be started on oil alone, the arrangement should also include a small container for a few ounces of gasoline, to be used until the parts are hot enough to vaporize the oil. The change from gasoline to oil is usually made by means of a three-way cock. Patents have been secured upon combinations covering certain specific methods of construction which embody this system of fuel oil injection, but the principle cannot be broadly claimed.

The hot plate above referred to is a piece of metal, usually of flat shape, and perhaps half as large as the cylinder bore, secured at one or more points to the inside face of the head. It should stand away from the head somewhat, and may be perforated with a number of small holes or slits, in order to permit the fresh charge to pass through and circulate more freely around it. Since it is not fully in contact with the metal of the head which is cooled by the jacket water, this plate will become quite hot and remain so. It will effectually gasify the oil, but the writer prefers to do away with the water cooled head and also the integral method of casting the cylinder, and use an unjacketed head, made separately and bolted on. This was the original practice, but was rather objectionable when gasoline came into use, as an unjacketed head is liable to preignite the charge. In the oil engine, however, the naked head carries the necessary heat for the

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vaporization of the fuel; it is easily removed and replaced, and when thus made, the cylinder is more readily machined. (See Fig. 5.)

The lubrication of a two-stroke cycle engine using gasoline is commonly accomplished by mixing the lubricating oil with the gasoline in the fuel tank. The air of the crank-case takes up the gasoline, but precipitates the oil very evenly upon the cylinder walls and all the internal parts of the engine. When oil is the fuel, the required lubrication must be applied by the use of oil cups.

In the operation of an engine using oil fuel in this way, there is little opportunity for loss of the exhaust, for the reason that the air entering the cylinder through the inlet port moves more rapidly than the liquid fuel, and by the time the latter has been completely gasified, the exhaust port has closed.

* * *

FLEXIBLE SHAFT COUPLING

At a recent exposition held in Dresden, Germany, the firm of Vogel & Schlegel of that city exhibited a flexible shaft coupling of the type illustrated in the accompanying halftone. The coupling consists principally of two disks, each keyed to one end of one of the shafts to be connected. The two disks are united on their inner faces by endless leather or canvas strips running around studs in the disks as indicated in the illustration. It is evident that this provides for a flexible drive, the starting up is more easy on the connected shafts and the machinery, and there is a tendency to eliminate the heating of the journals or bearings in cases where the shafts are not well lined up.

Flexible Shaft Coupling

The accompanying table gives the capacity of these flexible shaft couplings for transmitting power. The figures are converted into English measure from the tables given by the makers. The ratio $\frac{N}{n}$ is the maximum horsepower divided by the number of revolutions per minute.

CAPACITY OF FLEXIBLE SHAFT COUPLINGS

Ratio $\frac{N}{n}$	Turning Moment, Foot-pounds	External Diameter, Inches	Maximum Bore, Inches
0.00025	1.3	3.15	0.71
0.002	102 0	13.40	2.17
0.250	1288.0	26.60	4.13
1.000	5156.0	35.40	6.22
3.532	18239.0	49.20	8.66
7.610	39242.0	59.10	10.23

* * *

Superior methods for receiving and delivering freight are used in several European countries, notably in Great Britain and Belgium. As an example may be mentioned the conditions under which freight is handled in Brussels by the state-owned railroads. The railroads own and operate their own freight vans and trucks; freight rates are made directly to and from a man's place of business, and include the cost of collecting the freight and delivering it, as is the case with express rates in this country. On account of this systematic manner of handling freight, the number of trucks passing through the streets is very much decreased, as one van will collect all the freight on a given street or within a given territory. The freight is not stored in sheds or in the cars as is frequently the case in this country, but is delivered at once. The results are: an elimination of congestion of freight cars at terminals; a smaller number of idle freight cars; and decreased demand for extensive track facilities at terminals.

STANDARD AUTOMOBILE LOCK WASHERS

Lock washers have hitherto been made to a great many different dimensions. It is stated that one firm alone has made as many as 700 different sizes. For this reason the Society of Automobile Engineers has issued tables giving standard sizes for lock washers, for use on automobiles, which reduce the number to twenty-eight. These sizes have been adopted after careful consideration of the requirements. A number of engineers regarded the sections used against iron and steel as too heavy for use against soft metal, and for that reason a standard was adopted for washers having less depth, which will not mar such metals as aluminum, for example.

TABLE OF STANDARD AUTOMOBILE LOCK WASHERS

AUTOMOBILE HEAVY (A. H.)

Bolt Diameter, Inches	Lock Washer Section, Inches	Bolt Diameter, Inches	Lock Washer Section, Inches
3/16	1/16 x 1/16	11/16	1/4 x 1/4
1/4	5/64 x 5/64	3/4	1/4 x 1/4
5/16	1/8 x 1/8	7/8	17/64 x 17/64
3/8	1/8 x 1/8	1	5/16 x 5/16
7/16	11/64 x 11/64	1 1/8	5/16 x 5/16
1/2	11/64 x 11/64	1 1/4	3/8 x 3/8
9/16	13/64 x 13/64	1 3/8	3/8 x 3/8
5/8	13/64 x 13/64	1 1/2	7/16 x 7/16

AUTOMOBILE LARGE (A. L.)
For Optional Use against Soft Metal

Bolt Diameter, Inches	Lock Washer Section, Inches	Bolt Diameter, Inches	Lock Washer Section, Inches
3/16	1/16 x 3/64	9/16	13/64 x 5/32
1/4	5/64 x 1/16	5/8	13/64 x 5/32
5/16	1/8 x 3/32	11/16	1/4 x 3/16
3/8	1/8 x 3/32	3/4	1/4 x 3/16
7/16	11/64 x 1/8	7/8	17/64 x 3/16
1/2	11/64 x 1/8	1	5/16 x 1/4

The specifications given are as follows: The outside diameters of lock washers shall coincide practically with the "long diameters" of the S. A. E. standard nuts, which are approximately equal to the "short diameters" of the U. S. standard nuts. The inside diameters of the lock washers shall be from 1/64 inch to 1/32 inch larger than the bolt diameter. All lock washers shall be of parallel-faced sections; bulging and malformed ends must be avoided. They are to be submitted to the following tests as to temper: After being compressed to a flat, the reaction shall be sufficient to indicate necessary spring power, and on a subsequent compression to flat, the lock washer shall manifest no appreciable loss in reaction. The test for toughness shall be made as follows: Forty-five per cent of the lock washer, including one end, shall be firmly secured in a vise, and forty-five per cent, including the other end, shall be secured firmly between the parallel jaws of a wrench. Movement of the wrench at right angles to the helical curve shall twist the lock washer through forty-five degrees without sign of fracture; and shall twist the lock washer entirely apart within one hundred and thirty-five degrees. The accompanying tables give the standard dimensions adopted.

* * *

According to *La Fonderie Moderne*, a French metallurgist has discovered a new copper alloy having the hardness of steel combined with great tensile strength. The alloy is made in the proportion of one pound of chromium melted for one hour with one pound of aluminum, after which twenty-two pounds of copper are added, the entire charge being kept at a fusing temperature for one-half hour. Five pounds of nickel are next added and the mixture is heated for another hour, after which four pounds of zinc are added. The proportion of copper and chromium may be varied somewhat in accordance with the use to which the alloy is to be put, but the quantities and directions given above must not be changed in any other respect.

NEW CASEHARDENING METHODS*

By E. F. LAKE†

During the past decade there has been a great deal of investigation relating to the conditions under which the various carbonaceous gases may be used in place of the familiar solid carburizing materials. Everybody using or making steel knows that the old method of carburizing, or casehardening, is to pack the pieces, with some such carbonaceous material as bone and charcoal, in an iron box, sealing on the cover to exclude the air, and then baking for several hours in a furnace. The furnace is kept at a temperature high enough to cause the steel to absorb the required amount of carbon from the bone and charcoal, or other carbonaceous material that may be used.

This process was the only one known for many centuries. It was used without a question of its superiority until the manufacture of armor plate became such a large industry that efforts were made to find a better, or cheaper, way of causing the carbon to penetrate this plate. The first method employed was to place an armor plate in a pit and cover it with a layer of charcoal, and then lower another plate onto it. The cover was then put on the pit and the plates heated to (or baked in) a temperature that was sufficient to cause them to absorb the carbon from the charcoal. Gas was generally used for the fuel, owing to the ease of controlling the heat. The next method tried was to send a current of carbonaceous gas between the two plates, in place of the charcoal. This caused the carbon to "soak in" in less time and was found more economical. Later, electricity was used for heating the plates, and with the carbonaceous gas and electricity, the carbon penetration was found to be more uniform over the entire surface of the plate.

TABLE I. RESULTS OF CARBURIZING STEEL WITH CARBON MONOXIDE FOR TEN HOURS AT 2000 DEG. F.

Depth from Surface at which Sample was Analyzed	Percentage of Carbon			
	Carbon Steel		Nickel-chrome Steel	
	CO Gas alone	CO_2 and Charcoal	CO Gas alone	CO_2 and Charcoal
$\frac{1}{64}$ inch	0.70	1.17	0.86	1.16
$\frac{3}{32}$ inch	0.67	0.81	0.87	0.81
$\frac{3}{16}$ inch	0.53	0.34	0.75	0.50
$\frac{5}{16}$ inch	0.39	....	0.59	....

The results obtained from the action of carbonaceous gas on armor plate have been such that a muffle carburizing furnace has been built and placed upon the market. This holds the work in a revolving retort, through which is sent a current of carbonaceous gas. This retort serves as a muffle that is surrounded with the flames of the heating gases. With this furnace, small pieces can be carburized in much less time than formerly, and at about one-half the cost as compared with packing in iron boxes and then baking in an oven furnace. All of the labor of packing materials is done away with; carbon will penetrate the metal in less time and more evenly; its depth and percentage can be controlled more easily; and the work can be heated to the carburizing temperature more quickly and maintained there more easily. A steady flow of carbonaceous gas can be kept passing through the retort, and thus any depth of carbon can be obtained without repacking the work.

When considerable depth of carbon is required, this is impossible with the old method of packing with bone and charcoal in an iron box and sealing on the cover. This is due to the fact that only a certain amount of carbon is present, and the longer the work is baked, the more there will be in the steel and the less in the charcoal. When an equilibrium is established, no more carbon will penetrate the metal, and to obtain a greater depth, the work must be packed in fresh carbonaceous material and the heating repeated.

With the gas process, however, the percentage of carbon in the gas surrounding the work can be maintained at a permanent figure until the carbon has penetrated to the center of the metal, the percentage of carbon possible to impart to the steel being far above that which is used for any kind of commercial work. Some of the gases that have been experimented with are methane, ethylene, illuminating gas, carbon monoxide, carbon dioxide, and gases that are made from liquids like petroleum, naphtha and gasoline. Most of these gases have been used in combination with ammonia, in order to ascertain to what extent this would aid in the penetration of the carbon.

From the numerous experiments that have been conducted it has been found that carbon monoxide is far superior to any of the solid carbonaceous materials in the specific, direct carburizing effect it has upon steel. It is also better than all other gaseous materials in this respect. Carburizing materials that do not contain nitrogen cost only from one-tenth to one-twentieth of the nitrogeneous materials. It has been found, however, that nitrogen acts as a carrier for the carbon, and when it is not present, carbonaceous materials have a very weak carburizing effect; some investigations have shown that the effect is absolutely nil without the intervention of gaseous carbon compounds. When solid carbonaceous materials are used, the specific effect of the nitrogen is very weak, and it is only when these contain a high percentage of the cyanogen compounds that they have any marked carburizing effect.

While carbon monoxide is capable of rapid penetration, it has an oxidizing effect on steel, and is liable to form a scale that will spoil small work which cannot afterwards be ground. This oxidizing effect is more pronounced in chromium and manganese steels. When carbon monoxide alone is used for the carburizing medium, there is a distinct demarkation between the carburized zone and the core of the metal. This is also a detrimental feature, in that when the piece is hardened, it has a tendency to crack at this demarkation, causing the outer shell to peel off.

To overcome these bad effects of carbon monoxide, a new process has been developed by Dr. F. Giolitti, Genoa, Italy. In this process the work is packed with wood charcoal in a cylinder, and when heated to the carburizing temperature, a current of carbon dioxide is injected into the cylinder. It was demonstrated that when a slow current of carbon dioxide traversed a mass of wood charcoal, the carburizing gas was supplied with great rapidity and without any excess of carbon monoxide. Thus, an equilibrium with free carbon was established at the carburizing temperature. The exhaust gas contained less than three per cent of carbon dioxide, it being almost entirely carbon monoxide, and its volume being about double that of the carbon dioxide which was introduced into the apparatus. Some results that were obtained with carbon monoxide alone, and in combination with charcoal, are shown in Table I.

TABLE II. RESULTS OF CARBURIZING STEEL WITH COMPRESSED GAS FOR THREE HOURS

Kind of Steel	Carburizing Temperature, Degrees F.	Pounds Pressure of Carburizing Gas	Percentage of Carbon at a Depth of	
			$\frac{1}{64}$ Inch	$\frac{1}{32}$ Inch
Nickel Steel*.....	1600	235	0.71	0.12
	1775	235	0.99	0.29
	1650	400	0.73	0.36
Chromium Steel†	1750	235	2.22	1.03
	1925	235	3.10	1.39
	1875	400	2.37	1.40
Chrome-nickel Steel‡.	1525	235	0.45	0.54
	1650	235	0.76	0.49
	1525	400	0.54	0.56

* Composition in per cent: Nickel, 5.02; carbon, 0.118; silicon, 0.20; manganese, 1.53.
† Composition in per cent: Chromium, 2.33; carbon, 0.41; silicon, 0.15; manganese, 1.02.
‡ Composition in per cent: Nickel, 3.17; chromium, 1.5; carbon, 0.33; silicon, 0.06; manganese, 1.15.

With the use of this new process, a more rapid penetration can be obtained than with any of the solid or gaseous materials, except pure carbon monoxide. The carbon is evenly distributed in the carburized zone, and the peeling of the outer

* See also papers read before The Iron and Steel Institute (Great Britain) at the October, 1911, meeting, by F. Giolitti, and by F. Giolitti and F. Carnevali.

† Address: 184 Ave. B, corner 47th St., Bayonne, N. J.

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shell, when hardened or tempered, is reduced to a minimum. Any desired depth of penetration can be obtained without renewing the carburizing material, and there is absolute security against the introduction of any foreign substance. Variations in the percentage and depth of the carbon can be obtained by diluting the carbon monoxide in nitrogen; by limiting the contact of the solids with the metal; and by varying the temperature during the carburizing operations. Expansion or contraction and warping of the pieces being carburized has also been reduced to a minimum. In fact, there are so many features that make it superior to the old method of packing and sealing the work to be carburized in iron boxes, that it is safe to say that the new process is incomparably better.

After much experimenting, Dr. Giolitti decided that the double muffle furnace, shown in Fig. 1, was the most efficient and economical for carburizing small or medium size pieces of varying shapes. By providing two muffles, one could be filled with work and kept at the carburizing temperature, while the other was being emptied and refilled. If the amount of work would warrant, many more muffles could be used in the same furnace. The scale to which the illustration is made, as indicated in the lower left-hand corner, will give an idea of the size of this furnace, but the size would, of course, have to be figured from the size and class of work that is to be carburized. The muffle to the right is shown by a sectional view through the center of the furnace, but the retort that holds the work is not sectioned, while the muffle to the left is shown by a sectional view on the center line, thus revealing the interior.

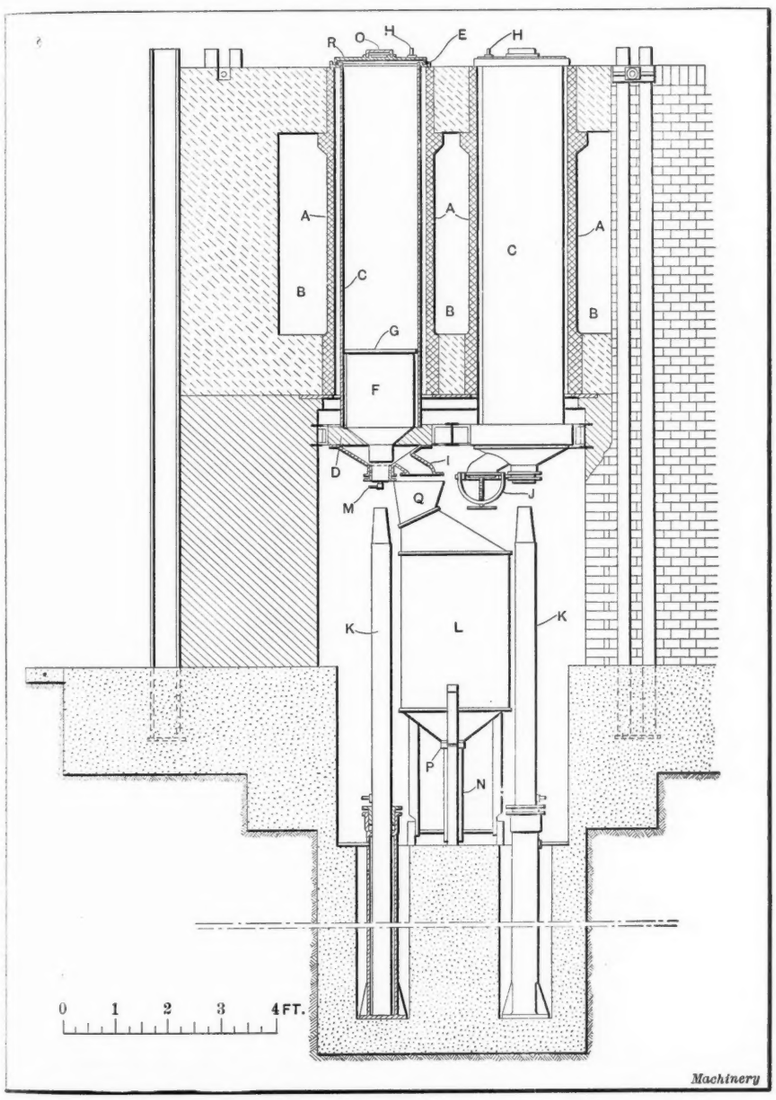

Fig. 1. Muffle Furnace for Carburizing Steel with Charcoal and Carbonaceous Gas

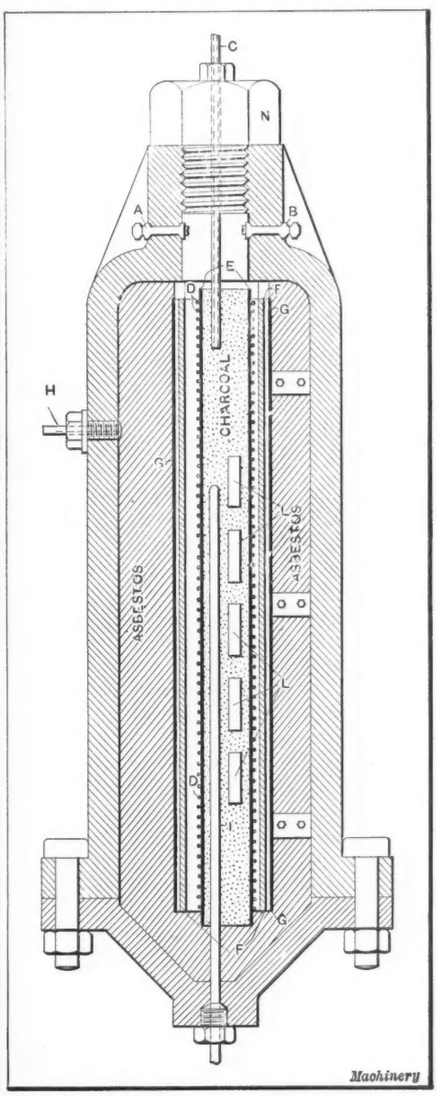

Fig. 2. Carburizing with Compressed Carbonaceous Gas and Electric Heating

Cylindrical muffles *A* are made of some refractory material and are built into the brick-work of the furnace. Surrounding them are passages *B*, in which the combustion of the heating gases takes place. These passages are lined with fire-brick or fire-clay and the furnace is provided with regenerators, so that the fuel gas, which is furnished by producers, can be used in the most economical manner. By this arrangement and the valves that are supplied, it is possible to maintain the work at a uniform pre-determined temperature. The work-holding retort *C* is made of seamless steel tubing and sets into flange *D*, which latter is attached to a frame that fits into the brick-work underneath the heating chamber. Flange *E*, which is made U-shaped to hold cover *R*, supports retort *C*, at the top of the furnace. Thus, it is only the work of a few minutes to take out retort *C* and replace it with a new one, when it has become warped out of shape or burnt through.

Inside of retort *C* is located a hollow cast-steel cylinder *F*, and inside of this is located a device that evenly distributes the carburizing gas around the work in the retort, by sending it through cover plate *G*, which is filled with holes. When all of the carbon is taken from the gas, it is allowed to escape through vent *H*. The work to be carburized is stacked up on cover plate *G*, which rests on casting *F*, and this in turn rests on the same flange *D* that supports the retort. To the bottom of this flange is attached the cast-iron nozzle *I*, which is closed at the bottom by the non-return valve *J*. Underneath the muffles are located two hydraulic rams *K* and a cylindrical iron tank *L*, mounted on wheels, for handling the solid carburizing material, which is in a granular condition.

Tank *L* may be turned on its wheels so that spout *Q* will come under the nozzle *I* of either muffle.

In operating this furnace, a continuous method can be employed. When a batch of work has been carburized, the granular carbon is drawn off through nozzle *I* into tank *L*. After that, pipe *M*, through which the carburizing gas enters the retort, is unscrewed, and ram *K* raises steel pot *F* towards the top of retort *C*, thus pushing the work that rests on plate *G* up with it, so that it can be removed as the ram proceeds upwards. When casting *F* has reached the top of its stroke, which is a little below the top of the furnace, and the old work has been taken out, new work is placed on disk *G*, which is lowered by ram *K* as fast as the work is located. When the retort is filled with work, tank *L* is wheeled out from under the muffles and raised over the top of the furnace with a hoist on a swinging arm. When over the top of the furnace, pipe *N* at the bottom of tank *L* is lowered into opening *O* in the center of cover *R*. Valve *P* is then opened to allow the hot granular carbon to flow out of tank *L* and fill the interstices surrounding the work.

If granular carbon is held at or near the carburizing temperature, it acts very much like a liquid, and readily flows into all of the crevices surrounding the articles in the retort that are to be casehardened. When it is drawn off at the bottom of the retort it is at the carburizing temperature, and the time consumed in removing the finished work and replacing it with new is so short that the granular carbon does not cool down to a temperature below 1500 degrees F. Thus, it retains its mobility and flows around the work. An operator on top of the furnace might assist this flow by using iron rods that can be inserted into the retort through holes in the cover.

When the retort is properly filled, butterfly valve *P* is closed and tank *L* is lowered and wheeled to its position underneath the muffler. The work is then allowed to stand until the carburizing temperature has been reached. In the meantime, pipe *M* has been screwed into position, and when the carburizing temperature has been reached, the carbonaceous gas is injected into the retort through this pipe. While the work in the retort to the left is being carburized, the retort to the right can be emptied and filled, without in any way disturbing the process in the other.

Another method that has been tested by the designers of this furnace is that of compressing the carbonizing gases, and some very good results have been obtained. The tests demonstrated that when carbon monoxide acts on ordinary steel in the presence of free carbon, as in the furnace shown in Fig. 1, an increase in the depth of carburization will be obtained with an increase of the pressure on the gas, and there will also be an increased concentration of carbon within the carburized zone.

In carrying out some experiments of this nature, a cylindrical retort was used, like that shown in the sectional view in Fig. 2. In this, electricity was used to heat the work to the carburizing temperature. The work was packed in charcoal in a retort into which a current of carbon dioxide was injected, in a very similar manner to the method used in the furnace in Fig. 1. In the illustration, *A* and *B* are the clamps for the terminals and these conduct the current to nickel-wire spiral *D*. This wire is wound around porcelain tube *E*, which can easily be inserted into, or taken out of, the apparatus. By taking off nut *N*, tube *E* is readily slipped into fire-clay tube *F*, which is surrounded by steel tube *G* and insulated with asbestos. The carbon dioxide gas enters the retort through tube *C* and the used gas escapes through pipe *H*. Porcelain tube *I* contains a thermo-electric couple that is inserted into the retort at the opposite end from gas tube *C*. With it the temperature of the entire length of the casehardening chamber can be measured. Blocks *L* are the experimental pieces to be carburized, and are surrounded by granular carbon. Table II shows some results obtained with various kinds of alloy steels. While this is only a crude experimental apparatus, it would seem to suggest some ideas or principles that can very profitably be used for carburizing steel parts on a commercial scale.

Definite proof was obtained that variations in the pressure of the carburizing gas were always accompanied by variations in the depth of carburization, and also in the percentage of carbon in the carburized zone. It was found, however, that when the pressure was too high it would cause an oxide to form on the steel and this was more pronounced with chromium and manganese steels than with others. It was also found that as the carburizing temperature was raised, the pressure could be increased without causing this oxide to form. Thus, the higher the carburizing temperature, the higher can be the pressure used on the carburizing gas, with an absolute assurance that no oxidation will take place.

A rod of soft steel, 2⅜ inches in length and three-eighths inch in diameter, was casehardened for about three hours by heating three-fourths of an inch of its central portion to about 1800 degrees F. and allowing this temperature to decrease towards the two ends, so that at these the temperature was about 900 degrees F. Unmistakable carburizing took place in all portions that were above 1450 degrees F. The surface was absolutely unaltered in the hottest portion in the center, which was also the most intensely carburized, while a distinct layer of oxide was seen in the cooler portions, this oxide thickening as the temperature lowered towards the ends.

Such good results were obtained by compressing the carburizing gas as it was injected into the bed of charcoal in which the work was packed in the retort, that this method promises to become a commercial success. While the mixed agent, carbon monoxide and charcoal, increased both the speed of penetration and the percentage of carbon in the carburized zone over all previous methods or materials used for carburizing steels, compressing the carbon monoxide has still further increased these factors. Like all methods and processes, however, it must be handled properly. The amount of compression, as well as the carburizing temperature, varies with different kinds of steels. Therefore, these must be discovered and properly adjusted, if work is to be turned out that is free from oxide and scale, and that has the desired penetration uniformly distributed over all portions of the exposed surfaces.

Whether work is carburized with an ordinary flow of carbon dioxide into and through the charcoal, or by compression, the advantages which vertical muffles, as shown in Fig. 1, have over horizontal muffles are in the greater speed of charging and removing the work, due to the greater simplicity of the operations, the uniformity of the treatment of all pieces forming the charge, and the more uniform distribution of the carburizing gases, due to the spaces being reduced to a minimum.

The time for the various operations with the furnace shown in Fig. 1 is as follows: Charging the pieces to be carburized from 1 to 5 minutes, according to their size and shape; completely filling the retort with granular carbon from 1½ to 4 minutes; lowering ram *K*, replacing pipe *M*, removing tank *L*, and closing down cover *R*, 1 minute; drawing the granular carbon from retort *C* into tank *L*, 4 minutes; raising ram *K* and removing the work from the retort, 2 minutes. The time consumed in all the operations, where ordinary work is being handled would, therefore, be about ten minutes, but with specially shaped pieces and unfavorable conditions, this time might be extended to 30 minutes.

By pre-heating the work to a carburizing temperature before putting it into the retort, no time will be lost in fully heating it in this furnace. The temperature of the granular carbon can then be maintained nearly up to the carburizing temperature, as it will not be chilled by cold work. The process can thus be made strictly continuous. Under these conditions, a depth of carbon penetration of 1/32 inch can be given the work in one hour, and of 1/16 inch in two hours. Thus it will be seen that from 1¼ to 2½ hours is all that is required for the complete carburizing operations in one retort.

By using gas for fuel and gas for carburizing, the work can be controlled within closer limits than with any other process, unless it should be an electric one, and the arrangements of this furnace are such that its capacity for producing work is greater than that of any furnace which has been designed with the same size of work holder. If there is not enough work to keep both muffles going on pre-heated work, one of the muffles can be used as a pre-heating furnace, while

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the other is doing the carburizing. By alternately using the muffles for pre-heating and carburizing, an amount of work will be turned out that will compare favorably with any other casehardening furnace. If desired, the current of carbonaceous gas can be used for a whole or any given part of the carburizing time, and thus the results obtained can be made to cover a wide range. Where localized casehardening is required, the granular carbon can be drawn off until only enough is left to insure the chemical equilibrium in the gas, and by thus isolating the carbon monoxide, it will intensify its specific action.

* * *

THE PHOROGRAPH—A CRITICISM

By GEORGE L. SULLIVAN*

The writer was much interested in Mr. Moody's description of the phorograph, in the October number, but was unable to check the theory of the method or to see the utility of it. In fact, it seems that the method is simply a complication of the instant center and the resolution of motion methods, without any new results and a great deal less logic. In the examples given, the results are all correct except that, in the quick-return motion illustrated, the velocity of the oscillating arm is represented by the line $c_1d_1 - c_1e_1$, and it still remains to solve for the velocity of the ram in order to complete the solution. This is easily done by finding the horizontal component of the velocity of ce, but the writer does not know what the phorograph method would be. Incidentally, this is not the Whitworth quick-return. The Whitworth mechanism is shown on page 154 of the same number of MACHINERY.

In the first place, Mr. Moody says that he expects to find a point on link a which has the same velocity as some other point in the mechanism, but the "equivalent point" or "image" which he finds is not on link a. What he does do is to find a line, the length of which represents the velocity of the point bc to a scale in which length of a equals velocity of point ab. It is not at all necessary to confine ourselves to this scale; in fact it would be easier to assume that 1 equals the velocity of point ab; then the scale will be immediately known when the velocity of ab is known.

Fig. 1 shows how any scale may be used in finding the velocity of a point on a four-link mechanism. Let e represent the velocity of ab, and h be drawn parallel to b; then g will represent the velocity of bc to the same scale. For if we produce c and a they will meet at O_1, the instant center of b, or point about which b is rotating at this instant. Then, the

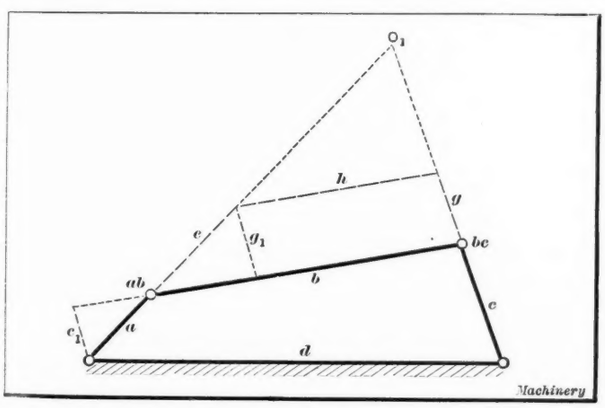

Fig. 1. Simple Four-link Mechanism analyzed by the Instant Center Method

velocity of ab is to the velocity of bc as O_1-ab is to O_1-bc, or as e is to g. Draw g_1 parallel to g; then g_1 is equal to g. Now if e is equal to a then g_1 is equal to c_1, which is also the c_1 of Mr. Moody's solution.

On top of page 107, Mr. Moody says that "every point in b, and b produced, has exactly the same direction of motion relative to the point of revolution ab." He means that the direction of rotation is the same. The direction of motion is directly opposite if the point is on the opposite side of ab. At the bottom of the same page, first column, he says "these images revolving instantaneously at a uniform speed." There is no such thing as an instantaneous uniform speed, because uniform speed means that the speed does not change from instant to instant, and we must consider more than one instant to determine whether the speed remains uniform or not.

In the analysis of the quick-return motion, the writer cannot see why the same reasoning is not applied to the motion of bc as is used in the analysis of the slide-and-crank mechanism, Fig. 3. In speaking of Fig. 3, he says "as b_1c_1 has a horizontal

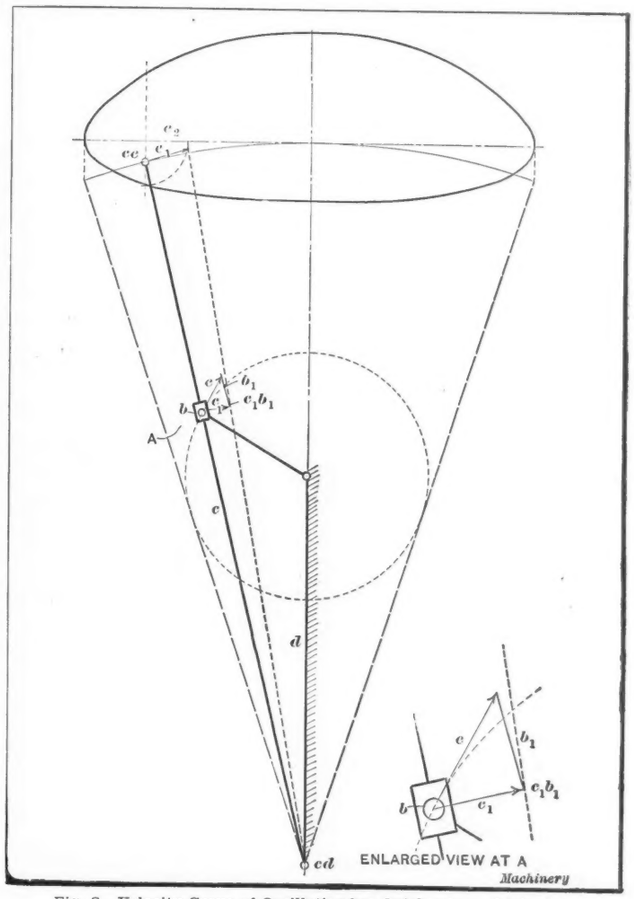

Fig. 2. Velocity Curve of Oscillating-bar Quick-return obtained by the Resolution of Motions

motion, it must be in a vertical line through da, as only such points in a have a horizontal motion." Apply the same reasoning to Fig. 4 and we have:

"The point bc moves in a line parallel to link c, and therefore must be in a line perpendicular to link c through da, as only such points in a have such a motion." This would throw the diagram off. What Mr. Moody really did was to let a represent the velocity of the block b. Then he resolved this velocity into the components b_1, perpendicular to c, and c_1, parallel to c; b_1 is the velocity of sliding of b on c, and c_1 is the velocity of the point bc in c. Now the velocity of ce is to the velocity of bc (in c) as cd–bc is to cd–ce. Fig. 2 shows the same thing done by the ordinary method. Let e represent the velocity of block b. Draw c_1 perpendicular to c and b_1 parallel to c through the extremity of e. Then c_1 is the velocity of bc (in c) and b_1 is the velocity of sliding of the block b on c. . Extend cd–c_1b_1 to meet a tangent drawn from ce. Then e_1 is the velocity of ce and e_2 is the velocity of the ram. The rest of the velocity diagram is determined in the same way. In Fig. 4, of Mr. Moody's article, it will be found difficult to project b_1c_1–c_1d_1 to a tangent from ce accurately. This will be avoided by the construction shown in Fig. 2 of the present article.

* * *

THE SAME MIGHT BE SAID OF TOOL STEEL

"There are over a million brands of cigars", observed the loquacious traveler. "Yes, and only two kinds", said the cigar salesman sententiously. "What are they?" "The kind that sells, and the kind that doesn't."

* Consulting Engineer, Bozeman, Mont.

MAKING THE PRESS-BUTTON KNIFE

By G. P. CAMPBELL*

There is hardly a manufacturing industry in the United States today in which machinery is used to a lesser extent than in the cutlery or knife business. While the machine is an important factor in producing, forming and handling different parts of the knife, yet, owing to the vast number of styles and the peculiar shapes of knives, nothing has yet been devised to take the place of the skillful hand of the cutler. A factory which to some extent constitutes an exception to this rule is that of the Press Button Knife Co., in Walden, Orange Co., N. Y., where the press-button knife is made. Mr. George Schrade, who is the inventor of this knife, is also the designer of the special tools used in its manufacture. He has recently severed his connection with the company mentioned, and is now engaged in the business of making new and improved machinery for manufacturing cutlery.

With the exception of the blade, which is hand-forged and largely finished by hand, and the coverings, all parts are produced and finished by machinery, and are ready to be put together without any fitting. The knife shown in Fig. 2 is

Fig. 1. Works in which Press-button Knife is made, Walden, N. Y.

a large one-blade pocket-knife. It is composed of twenty-seven different parts, requiring 112 different operations, nearly all of which are performed by machinery and with the use of the tools shown in Figs. 2, 3 and 4. All of these tools are used for making this one style of knife only.

Fig. 5 shows the different parts ready to be assembled. In this engraving *A* is the blade; *B* and B_1, the linings; *C*, the back; *D*, the coverings; *E* and E_1, the bolsters; *F*, the fly-spring, which opens the blade; *G*, the lock-spring, which locks the blade either in its open or closed position; *H*, a washer for the lock-spring; and *I*, washer *H* riveted over the lock-spring *G*. Further, *K* is the push button, *L* is a bushing, *M*

Fig. 2. Tools used in making the Press-button Knife

is a lock-pin for the lock-spring *G*, and *N* is a stud by which the lock-spring and the washer are riveted onto the linings B_1. At *O* is shown one of four German silver pins which fasten bolsters *E* and E_1 to linings *B* and B_1; *P* is one of four German silver pins which fasten coverings *D* to the linings; *Q* is one of a pair of German silver pins, one of which holds the fly-spring in place, while the other holds the covering,

* Address: 78 Mile Square Road, Yonkers, N. Y.

lining and back together; and *R* is one of three steel pins for fastening the linings, back and blade together before the covering is put on.

Tools and Operations

After the blade is forged it is drilled in jig *A*, Fig. 2, for the bushing *L*, and reamed with a spring socket reamer *K*, Fig. 4. This reamer is used in conjunction with part *L*, Fig. 4; the pressure of the spring of the reamer on the blade

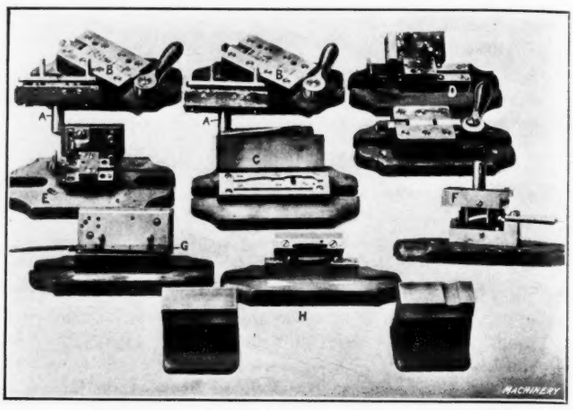

Fig. 3. Another Set of the Tools used in Press-button Knife Making

holds the latter down level on *L* while reaming. The two lock holes *S* and *T* in the blade, Fig. 5, are now drilled in jig *A*, Fig. 4, for lock-pin *M*, Fig. 5. This latter is riveted onto the lock-spring and protrudes through lining B_1, holding the blade either open or closed as mentioned. The tang or flat part of the blade is now milled in the milling machine in a jig, not shown, a shoulder being formed on the blade as shown at *U*, Fig. 5. The blade is now placed on a pin which holds it through hole *Y*. This pin is located a certain distance from a grinding wheel and the blade is swung around against the revolving wheel which grinds the tang to the

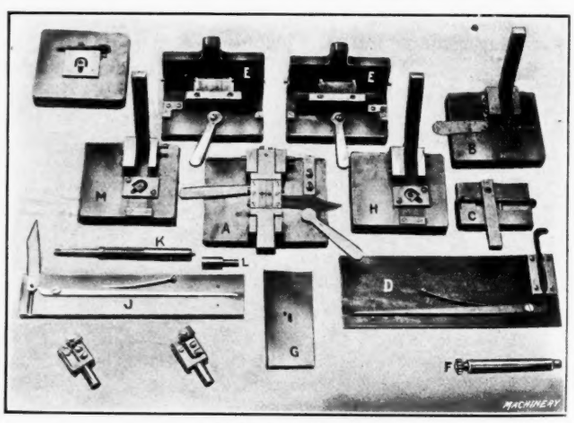

Fig. 4. Additional Knife-making Tools

required radius or shape. The tang is now stamped, the cutting part of the blade is hardened, tempered and ground to shape, and the tang is glazed. The blade is now ready to be inserted in the knife.

In setting up the knife blade for cutting the square shoulder in the milling machine, the gage shown at *J*, Fig. 4, is used in testing for accuracy; the blade is shown in this gage in position for testing. The distance from the shoulder of the blade to the pivot of the indicator is one-tenth of that from the pivot to the extreme point of the indicator, so that all errors are shown in a scale of 10 to 1; the graduations read in thousandths of an inch. The gage *G* is used for testing the accuracy of the lock-pin holes *S* and *T*, Fig. 5.

Die *B*, Fig. 2, is used for blanking the linings *B* and B_1, Fig. 5. These linings are then perforated in die *C*, eleven holes being punched in one and twelve in the other of the two lining pieces. These holes are punched in one stroke of the press. The holes for the pins in the linings are then countersunk to allow for riveting in a foot-press with the tools shown at *D*. They are then put into tools *B*, Fig. 3, and pins

O, *P* and *R*, and stud *N*, Fig. 5, are inserted and riveted in one operation. The upper parts of the tools *D*, Fig. 3, are shown at *A*. Bushing *L*, Fig. 5, is inserted and secured in place by the tool *E*, Fig. 2.

The lock-hole in lining B_1 is now reamed in jig *B*, Fig. 4, the lining being shown in position in the tool. The knife-backs *C* are first punched out or blanked in die *F*, Fig. 2. They are then cut off or cropped in tool *G*, after which they are "dotted" or centered for drilling in jig *C*, Fig. 3. Then they are held in jig *C*, Fig. 4, and milled to exact length. One of the backs is shown in position in this jig. They are then tested in gage *D*, this gage being constructed on the same principle as gage *J*. The four holes in the back are now drilled rapidly and accurately in one operation.

In the knife shown, the coverings *D* are of buckhorn, but they are also made in shell, ebony, aluminum or German silver. The coverings are cut to length, width and thickness on a small circular saw, after which they are cut to the shape of the lining. The ends, which join the bolsters *E* and E_1 are matched on a coarse wheel, after which they are both drilled in jigs *E*, Fig. 4, the four holes for pins *O* and *Q*, Fig. 5, being drilled in each at one operation. The coverings are now grooved with a milling tool *F*, in a jig not shown. This groove allows space for the lock-spring and washer *I*.

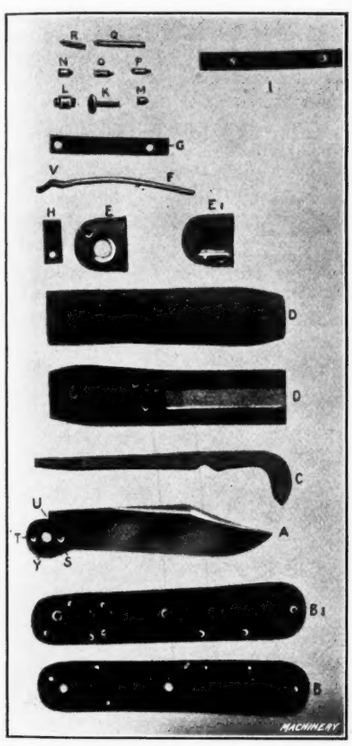

Fig. 5. Parts of the Press-button Knife

Bolsters *E* and E_1 are generally cast or drop-forged of German silver. In the case shown they are cast. The bolster *E* is drilled for pin fastenings and push-button in jig *H*, Fig. 4, and afterwards countersunk in jig *M*. Fly-spring *F*, Fig. 5, is made in forming and cutting-off tool *F*, Fig. 3, which forms and cuts off the spring in one operation. After this the spring is hardened, tempered and ground. The indentation shown in the spring at *V*, Fig. 5, fits a corresponding recess in the back *C*. The pin *Q* passes through holes in the linings and holds the fly-spring accurately in position.

The lock-spring *G* is first punched and cut to length in tool *D*, Fig. 3; then lock-pin *M* is put in and riveted in tool *H*, Fig. 2. The spring is then bent to the correct shape in forming tool *H*, Fig. 3, after which it is hardened and tempered. The washer *H*, Fig. 5, for the lock-spring, is made in a combination punching, forming and cutting-off tool *E*, Fig. 3, the three operations being performed successively. A piece of stock is shown in position in the dies with a hole punched and the washer formed to shape and ready to be cut off to length in the next operation. The washers are then hardened and tempered.

The tool *K*, Fig. 2, is used for tightening the blade and for securing and spreading the bushing for the press-button. Tool *N* is used for riveting the push-button, and a knife is shown in position in this tool with all parts assembled except the covering. The three pins *R* which hold the linings and the back together, are put in and riveted in one operation in a jig *G*, Fig. 3. The fly-spring is dropped in place and secured by pin *Q*, and the bolsters and coverings are now put on. The blades are then set by the cutler. The operation consists in "straightening" the blades by tapping with a very hard and sharp hammer on the hollow side of the tang, which is laid on the anvil, and which is not as hard as the rest of the blade. This operation bends the blade or "straightens" it, so that it is in the proper position to keep the keen edge from striking the lining or another blade, where there is more than one. The handle of the knife is now ground smooth and finished by an operation called "hafting." The blades are next polished, etched and finally edged on an oilstone. The knives are now ready for inspection, packing and shipping.

In opening the knife the push button is simply pressed, and as the end of the button rests against the lock-spring *G*, it forces this spring back and releases lock-pin *M*, which protrudes through lining B_1. The fly-spring pressing against the tang then causes the blade to fly open, and when hole *T* in the blade is opposite the lock-hole in lining B_1, the lock-pin slips into the hole and locks the blade in the open position. To close the knife the operation is reversed.

General Features of the Press Button Knife Co.'s Shop

There are a number of features in the shop of the Press Button Knife Co. that may be of interest. At each wire rack in the shop a wire gage is conveniently attached by a chain, and a great deal of time is saved throughout the year by this arrangement. Each man has his own individual oil can with a brass tag soldered onto the button with his number. Oil cans belonging to special machines have the number of the machine on them, and the can is expected to be found full and ready for use at all times. A place is provided on each machine for holding the can in a position convenient to the operator. All pins, studs, and bushings are made on a No. 00 Brown & Sharpe automatic screw machine, and the writer understands that this machine does the work formerly done by three hand-operated machines, each having an individual operator. The automatic machine requires attention for about one hour daily, or a total of about six hours per week.

Another feature of this shop is the close attention paid to details, such as the placing of material convenient for the operator. All wire of different kinds and sizes is kept in racks close to the automatic machine, so that the operator practically can reach it without moving from the machine. This feature is observed throughout the shop wherever feasible. Where small pieces are handled by the thousands, it makes a great deal of difference in the results whether the operator moves his hand or arm six or sixteen inches for each.

Instead of ordinary waste, silk waste is used in this shop, made into pieces the size of an ordinary wash rag. These can be washed when dirty, and can thus be used many times before becoming useless. The absence of lint and the non-clogging of oil holes are alone forcible arguments in favor of using this kind of waste instead of the ordinary loose cotton waste.

* * *

LARGE-APERTURE PHOTOGRAPHIC LENS

The Emil Busch Optical Co., 35 Charles St., Hatton Garden, London, E. C., England, has placed on the market a photographic lens which can be used for taking photographs of machinery in poorly lighted shops. This lens is called the "Glaukar" anastigmat. The principal features are the very large aperture and flatness of the field, as well as great covering power and fine definition. This lens was used by Sir Benjamin Stone for taking instantaneous pictures of the coronation ceremonies in Westminster Abbey, London. It has an aperture of F 3.1, which is large enough to enable pictures to be taken instantaneously even in very unfavorable lighting conditions. It is especially valuable for cinematograph work.

* * *

China has been moving forward industrially rapidly during the last few years, and few people realize how much the Chinese are now able to do for themselves in the mechanical and engineering fields. As one example, it may be mentioned that the Hanyang Iron and Steel Works employs 20,000 men, and that at these mills all the rails used for the Great Central Railroad of China from Peking to Hankow, some 700 miles, were rolled. There is at present 6000 miles of railway in operation and about 14,000 miles in prospect or under construction. Some lines have been constructed entirely by the Chinese, no foreign engineers having been employed.

THE FORMS OF LATHE BEDS—2

By JOSEPH G. HORNER*

Lathe Beds of Circular Section

The circular bed is cheaply made for small lathes of, say, from 6- to 10-inch swing. It is used for these, not so much because it happens to be the stiffest form, but because of the advantage which it offers for swivelling the rest to different angles, thus making it a kind of universal tool for all kinds of cutting. This design is adopted in the recent lathes of that type built by Messrs. Drummond Brothers, Ltd., of Guildford, England. The bed, of cast iron, 3 inches in diameter,

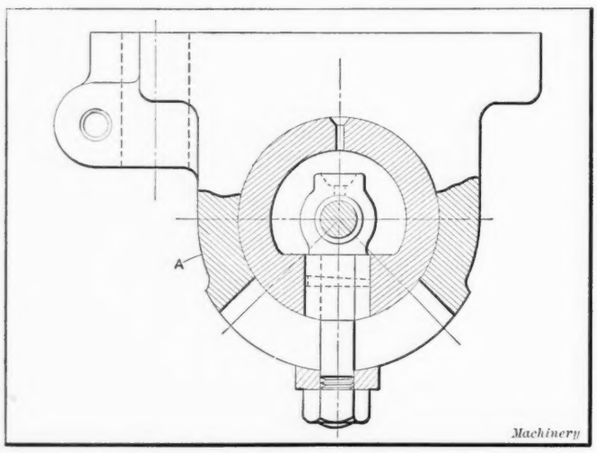

Fig. 26. Section of the Circular Bed for Lathes made by Drummond Bros., Guildford, England

is of hollow form, ground on the outside to a limit of 0.0001 inch, and on it the heads and saddle fit. As seen in Fig. 26, there is a slot in the under side of the bed which receives a tongue or bush secured to the bolt that passes up to transmit the motion from the lead-screw. By tightening the nut on this bolt the swivelling portion *A* is locked. The range of swivel is indicated by the radiating center lines. Fig. 27 shows the complete tool-rest, with the upper part held in the split socket of the saddle, thus permitting of a horizontal swivel movement which enables the tool, or the top of the rest, to be moved in a universal manner.

This lathe, in its swivel action, resembles the Pittler lathe,

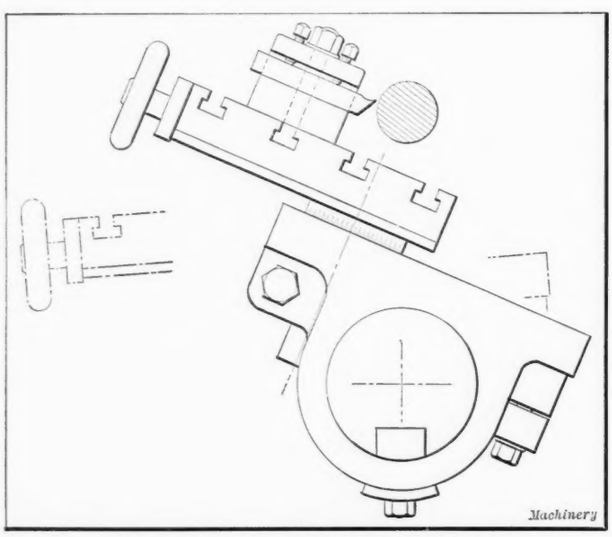

Fig. 27. The Drummond Lathe Bed and Saddle

although the latter is designed in a different way. In the Pittler lathe, the longitudinal guidance is provided for by a section of trapezoidal shape, within which the lead-screw passes. The form of this bed is plainly indicated in Fig. 28. The swivel motion is provided for by making the outside of the sliding carriage circular, and fitting the saddle of the slide-rest to it. In this way the sliding movement is combined with a circular movement through a complete circle. The stem of the tool-rest can be swivelled in the socket in the split saddle. The greatest swing to which lathes of this model are built is 14 inches. Pittler lathes of greater swing are built with approximately rectangular beds, having a vee and a flat guide.

The advantage of the circular form is also recognized in cases where it cannot be adopted absolutely. Some of the bench lathes have beds of D-section; one made by the Pratt & Whitney Co. of Hartford, Conn., is shown by Fig. 29. The headstock, tailstock and slide-rest are clamped to the flat top-face and are guided by the two sloping edges, thus preserving the alignment. The bed being small, is cast in one piece with its two feet.

The "Narrow Guide" Lathe Bed

We now come to a recent development in lathe bed practice, which has already, in the short course of some five or six years, effected a remarkable revolution in lathe construction—the application of the principle of the narrow guide. This principle, although so lately taken up in earnest, is not by any means new. To determine the period of its first application would seem impossible, but illustrations showing the idea applied to lathe carriages appeared some twenty-five or thirty years ago. The three illustrations Figs. 30, 31 and 32, are taken from Joshua Rose's "Modern Machine Shop Practice," and show how the principle was applied many years ago. All three of these illustrations are represented

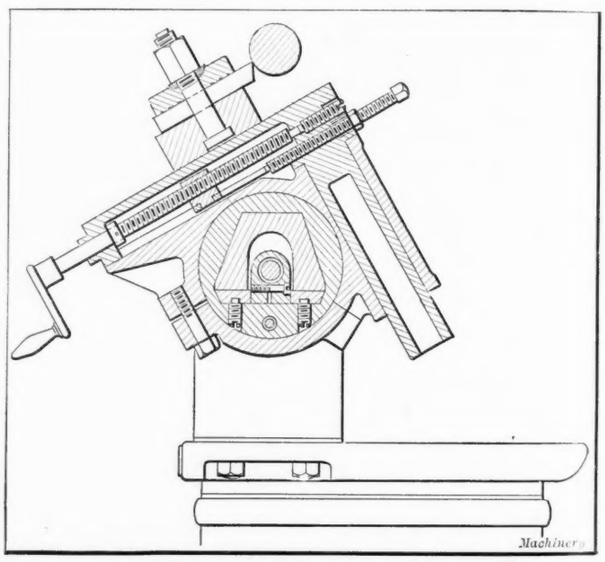

Fig. 28. The Pittler Trapezoidal Bed used by the Leipziger Werkzeugmaschinenfabrik, Leipzig-Wahren, Germany

in recent practice, and it is noteworthy how the construction has been brought into prominence chiefly by the development of high-speed lathes. Messrs. John Lang & Sons, when they re-designed their beds in 1900, embodied the narrow guiding strip in the design, and since that date its use has spread rapidly, not only as applied to lathes, but also as adapted to many other machine slides. New examples occur from month to month.

In the narrow-guide beds, the carriage or saddle is not in sliding contact with the vertical edge of the back shear, but has a clearance there, and is gibbed against the vertical edges of the front shear only. The only gibbing on the back shear is under its lip, merely to prevent lifting. As an alternative, the saddle may be guided by a raised strip on the front shear, or by an underhanging strip, without affecting the principle. Sometimes the strip is raised above the general level of the bed surfaces, and sometimes it is formed by making a recess or channel in the front shear, although this is open to the objection that such a recess easily collects and stores the chips. The upstanding ledge, again, is more liable to become damaged.

Fig. 34 illustrates the Lang bed with its saddle. It is possible with this design to obtain a length of guide of as much as ten times the width between the guiding surfaces,

* Address: 45 Sydney Bldgs., Bath, England.

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which has the effect of producing a very steady movement, with a much greater amount of freedom from twisting than is the case when the saddle fits on the front and rear outer edges of the shears. The setting-up of the taper adjusting-strip can have no possible tendency to spring the sides of the bed inwards, as it might possibly have in the ordinary type of lathe bed.

In conjunction with the narrow guide, it is also the practice to bring the lead-screw as close as is practicable to the guide-ways, and the twisting tendency and friction caused by the old-style construction is minimized. Thus, the location of the lead-screw in Fig. 12 is just where it ought not to be with relation to the saddle slides, and this example of what was at one time standard English practice contrasts unfavorably with the location of the lead-screw in Fig. 33 and some of the succeeding illustrations, where the force is applied at the correct place—near to the guide-ways. It has been found from experience that the narrow guide principle does give far more accurate results than the usual design, and that the alignment of the saddle movement is preserved for a longer period.

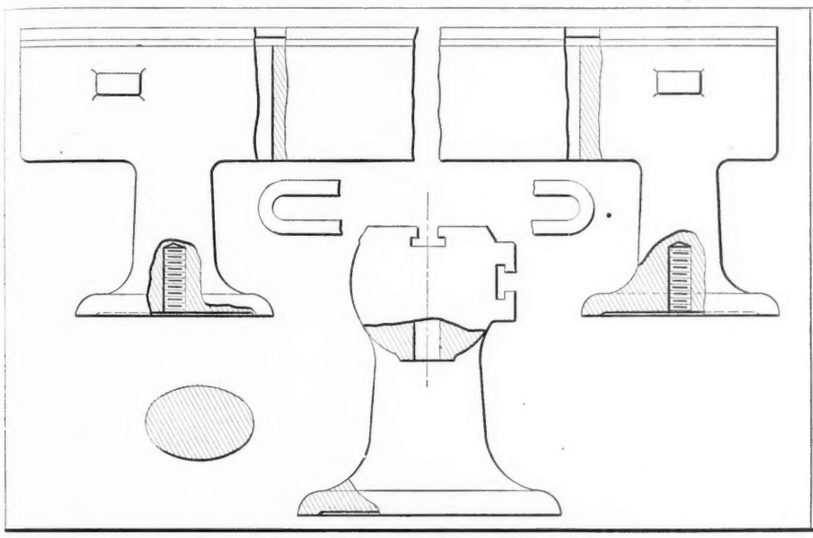
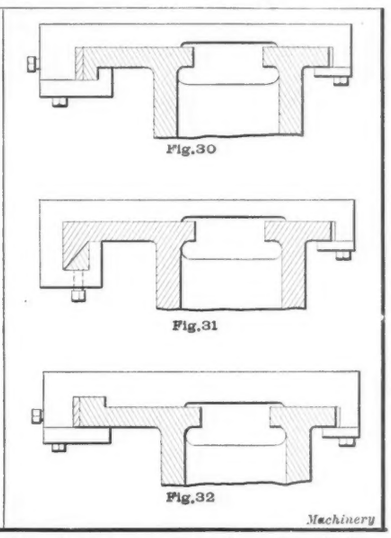


Fig. 29. Bed of the Pratt & Whitney Bench Lathe



Figs. 30, 31 and 32. Examples of Early Lathe Beds having Narrow Guides

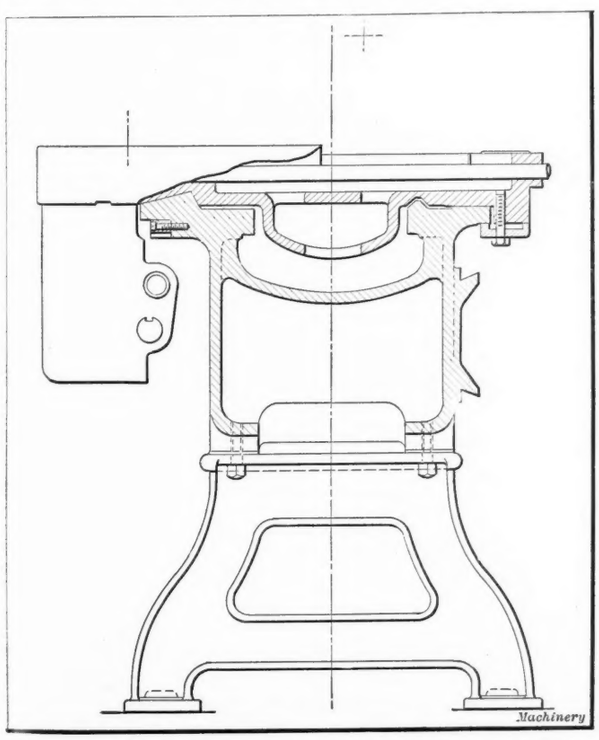


Fig. 33. The R. K. LeBlond Machine Tool Co.'s Design of Lathe Bed

American Designs Embodying the Narrow Guide Principle

Another important advantage, apart from the narrow guide itself, is that part of the pressure of the cut is resisted by a vertical face, and the forces tending to push the saddle off the bed are acting against this face, instead of against the back edge of the rear shear. This feature is also embodied in two new American designs, by the R. K. LeBlond Machine Tool Co., and the Lodge & Shipley Machine Tool Co., both of Cincinnati, Ohio. In the former company's design a nearly vertical face is employed on the front shear, and in the latter's design the vertical inner edge of the front shear comes in contact with the carriage. The LeBlond lathe, Fig. 33, is not provided with a rear vee, the carriage sliding

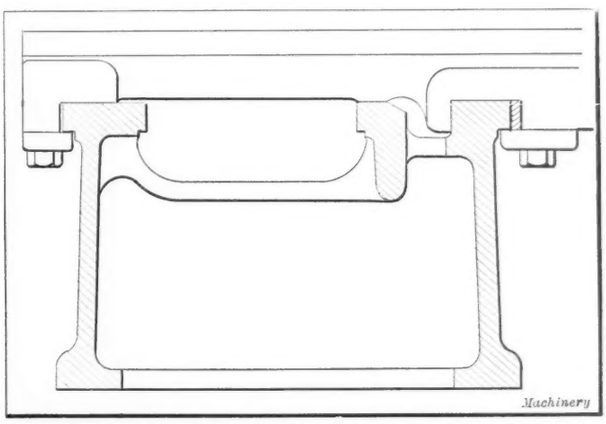


Fig. 34. The John Lang & Sons, Johnstone, Scotland, Type of Lathe Bed

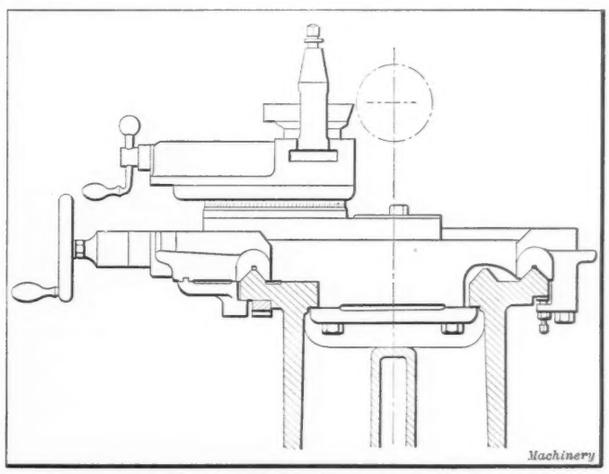


Fig. 35. The Lodge & Shipley Machine Tool Co.'s Lathe Bed with Supplementary Bearing Surface

on a flat on the back shear, but in the Lodge & Shipley lathe, Fig. 35, the carriage fits on the usual rear vee, and in addition has a horizontal bearing on the surface adjacent to the front vee, so that the solid metal of the carriage is well supported.

Belgian Type of Narrow Guide Lathe

The firm of Le Progrès Industriel, Société Anonyme, of Loth, near Brussels, who has been engaged in lathe manufacture for many years, utilizes, in its present design, the narrow guiding principle, in conjunction with a single vee for the guidance of the tailstock. The carriage, as indicated in Fig. 36, does not touch this rear upstanding vee, and there is a clearance at the rear vertical edge of the rear shear. The adjustments are made by a wedge strip on the front edge of the front shear and by the two gib strips each underneath the lips. This design is a sort of compromise between American and English designs, and is used on large and small lathes alike.

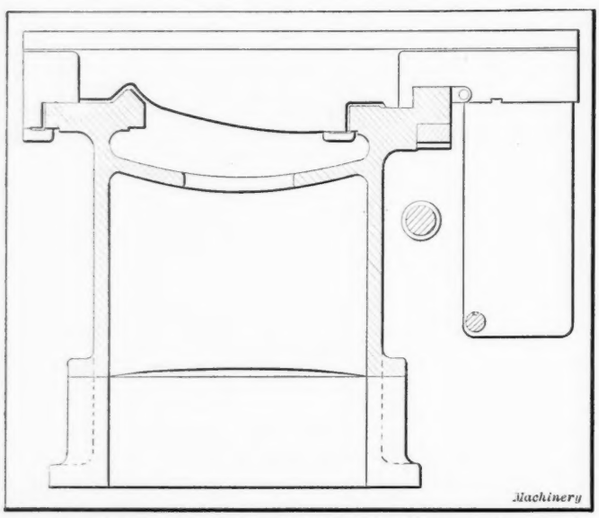


Fig. 36. Belgian Design of Lathe Bed with Raised Narrow Guide as used by Le Progres Industriel Societe Anonyme, Loth near Brussels

Modification of Design of Narrow Guide Lathe Beds

Several firms, instead of arranging a special strip for guidance, take the English bed as it is and utilize the front shear for the narrow guide, thus simplifying matters and obtaining an excellent support for the carriage just where it is most needed. Thus, Messrs. John Stirk & Sons, Ltd., of Halifax, England, have adopted the method illustrated in Fig. 37. A strip is fitted against the front vertical edge, and the solid metal of the saddle fits against the inner face of the front shear. At the edge of the back shear there is a working clearance, and two gib strips are used as shown, to prevent lifting. It will be observed that the lead-screw is brought as close as possible to the guiding way. In this design the proportion of length to width of the narrow guide is about 4 to 1, but, as mentioned previously, in some cases where a strip is employed, the proportion may be as high as 10 to 1. Some firms who retain the front shear for guidance, as in the example just referred to, lengthen the wings of the saddle to the right and left in order to increase the bearing length. The tailstock slides between these wings up to the main body of the saddle.

Another design of a new 20-inch high-speed lathe, made by Messrs. Smith & Coventry, Ltd., of Manchester, England, is shown in Figs. 38 and 39. The two views here given illustrate the method of fitting the saddle and the tailstock. The front shear constitutes the narrow guide, with its take-up strip on the front face. The horizontal bearing is amply provided for by three ways; on the two at the rear the tailstock slides, as shown by Fig. 38. Gib strips are located under the front and rear edges.

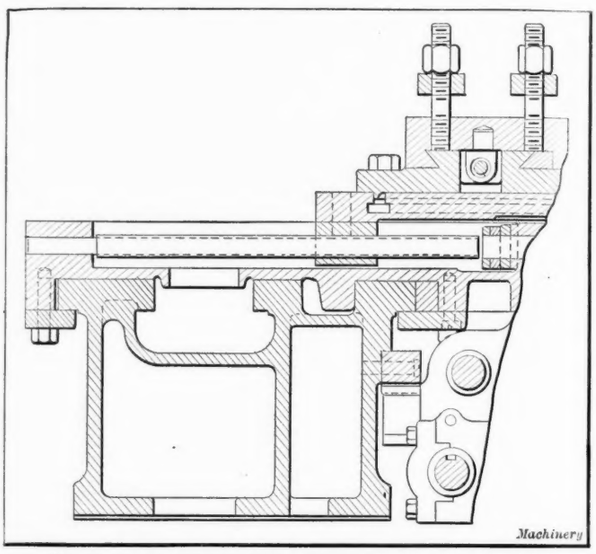


Fig. 39. Bed for 20-inch Lathe with Strip at Front, designed by Smith & Coventry, Ltd.

Messrs. Ward, Haggas & Smith, of Keighley, England, fit their lathes with a narrow guide of the type shown in Fig. 40. This design is of the inverted type, the take-up strip drawing the saddle against the inside sloping face of the hanging lip of the front shear. These surfaces are thus out of the way of the chips, and a great proportion of length to width of bearing surface is secured. The lead-screw and rack are brought very close to the guiding area. Fig. 41 illustrates the method of tightening the tailstock by a clamping plate which presses against a sloping face on the inside of the rear way, thus drawing the tailstock against the back

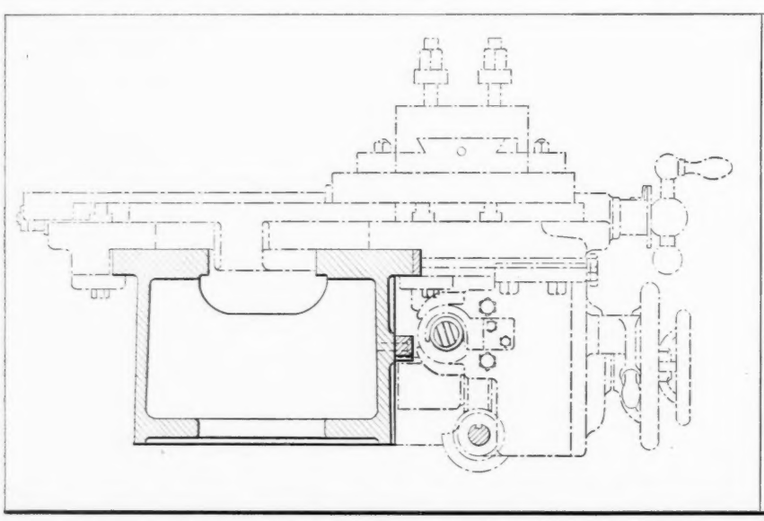


Fig. 37. Example of Narrow Guide on Front Shear of Lathe, designed by John Stirk & Sons, Ltd., Halifax, England

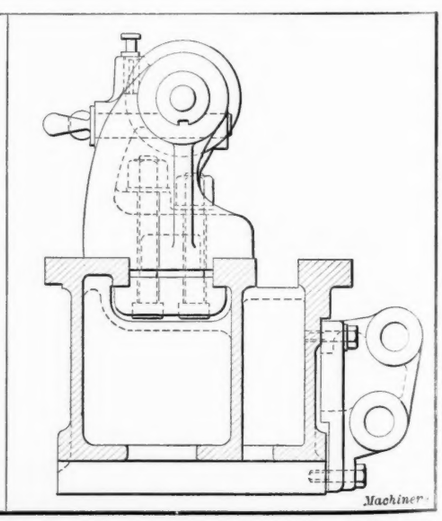


Fig. 38. Method of Fitting the Tailstock on Lathe built by Smith & Coventry, Ltd, Manchester, England

vertical edge of the shear. As this edge is not subjected to wear from the saddle, which clears it, the alignment is preserved indefinitely. Another example of an underhanging lip employed as a guide is that of the high-speed lathes built by Messrs. George Swift & Sons, of Halifax, England, as shown in Fig. 48, which shows the saddle without its apron.

In certain types of lathes one shear is employed alone to guide and support the carriage. This design is met with in a certain type of boring and turning lathe, where two duplicate carriages are run each on their own way, and are entirely independent of each other. A lower slideway or tier takes the overhang of the carriages. In another instance, that of the Libby turret lathe, made by the International Machine Tool Co., Indianapolis, Ind., the carriage fits over the front shear, as shown in Fig. 42, and a lower vee-guide opposes the tilting tendency of the carriage.

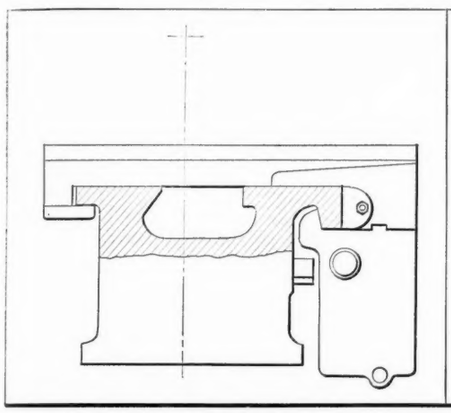


Fig. 40. Lathe Bed with Inverted Narrow Guide, designed by Ward, Haggas & Smith, Keighley, England

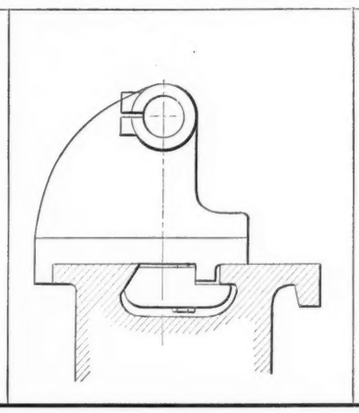


Fig. 41. Method of Clamping Tailstock to Bed shown in Fig. 40

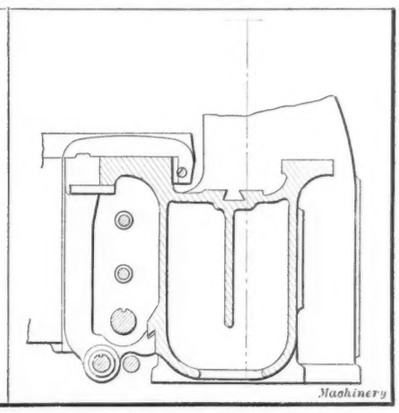


Fig. 42. Section of Bed of the Libby Turret Lathe, built by International Machine Tool Co.

Lathes with Carriage Support beneath the Shears

The principle of affording support to the carriage at some point situated below the general level of the bed surfaces is met with in several designs. Perhaps the most successful example is that of Messrs. Darling & Sellers, Ltd., of Keighley, England. A bed section of one of their lathes is shown in Fig. 44. The auxiliary or "lower-tier" bed is made in the form of a strong lip, projecting out from the front of the

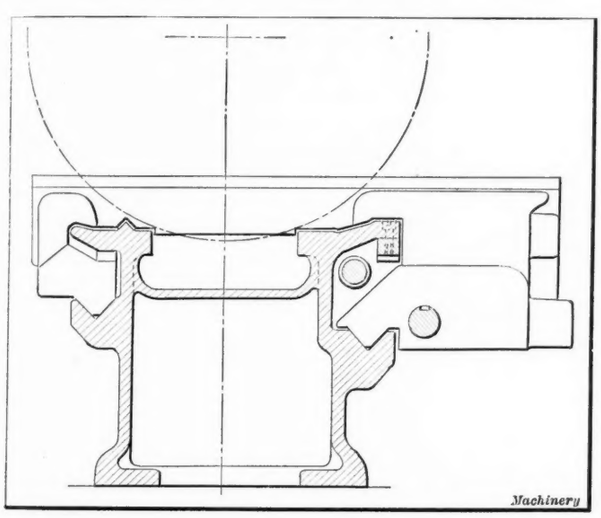


Fig. 43. Bed with Lower-tier Vee-ways as designed by Schaerer & Co., Karlsruhe, Germany

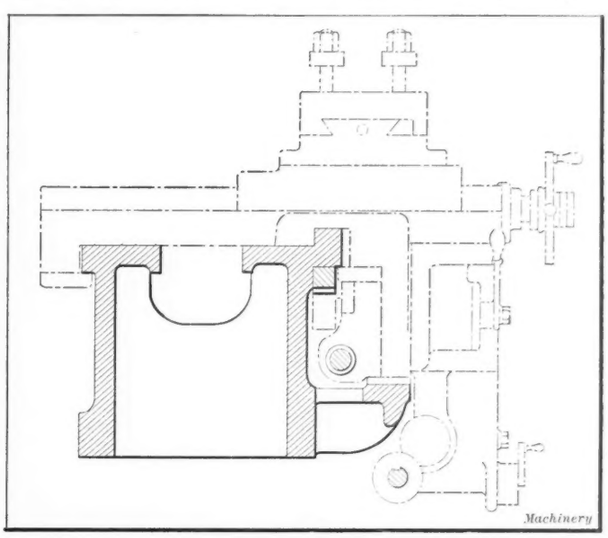


Fig. 44. Double-tier Bed with a Raised Narrow Guide on Lathe built by Darling & Sellers, Keighley, England

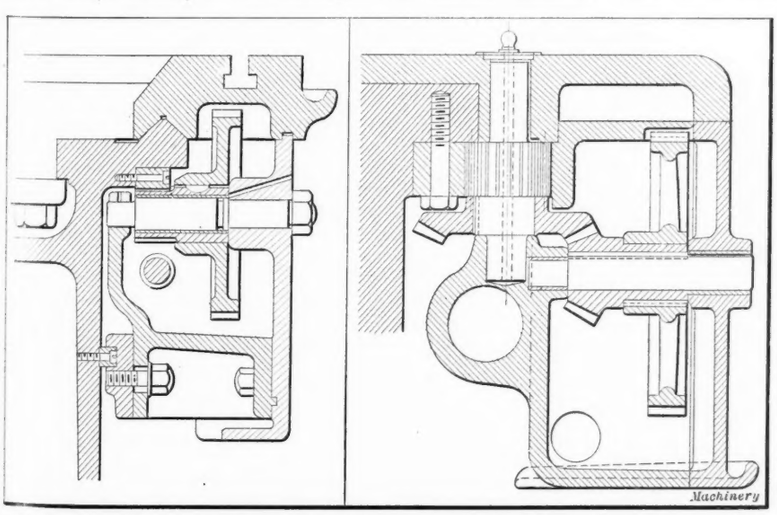


Fig. 45. Support for Apron on a Heavy Lodge & Shipley Lathe

Fig. 46. Vertical Rack and Pinion on Lathe built by Joshua Buckton & Co., Ltd., Leeds, England

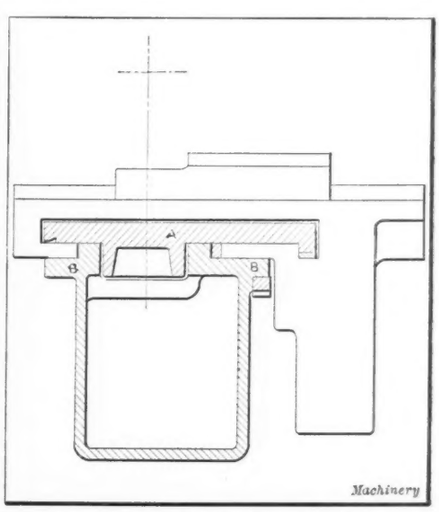


Fig. 47. The Protected Bed as made by George Richards, Ltd., London, England

bed near the bottom. The saddle has a bearing on this, as well as on the top surfaces of the bed. The overhanging weight of the saddle is thus supported in a very satisfactory manner, and it will be seen that the actual effective width of the bed is increased over that of the normal or apparent

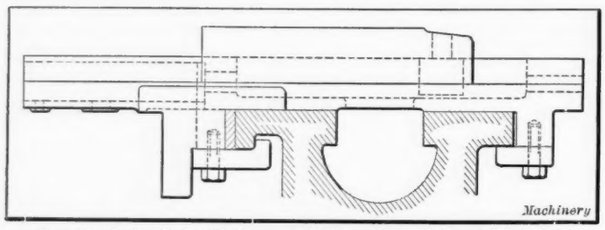


Fig. 48. Lathe Bed with Narrow Guide underneath Front Edge, built by George Swift & Sons, Halifax, England

width at the top. The advantage of this construction in turning large diameters, when the pressure is applied at the extreme edge of the bed, is obvious. The position of the lead-screw and rack eliminates undesirable twisting action. This bed is fitted with a narrow guide at the front edge, raised

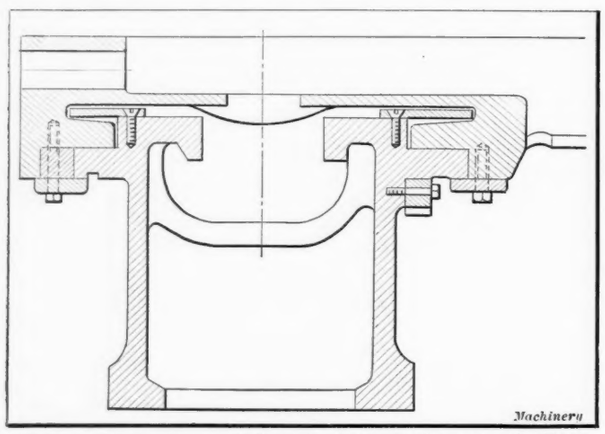


Fig. 49. A German Type of Lathe Bed with Guard Plates over the Slides

above the level of the bed as shown. A taper strip is used on the front face, and two gibs beneath the lips.

In Lodge & Shipley lathes of above 20 inches swing, a supplementary ledge is used, in the form of a steel strip let into and screwed to the front of the bed, as shown in Fig. 45. The back wall of the apron is supported by this ledge, which helps to resist the forces tending to separate the gears and rack and pinion, while under heavy duty. With a similar object in view, some makers support the rack-pinion by the metal of the saddle, in order (see Fig. 10) to prevent the springing away of the pinion. Another device is to alter the position of the rack and pinion to a vertical location, and support the pinion shaft in bearings on both sides of the pinion.

employed for their lathes having 15- and 18-inch swing. The gap is permanently open, and the saddle is guided by two lower tiers or slide-rails, so that it can be brought along on these past the gap and close up to the largest faceplate, with a minimum of tool overhang.

Another example of a lower-tier bed is that used in a lathe built by Schaerer & Co., of Karlsruhe, Germany, in which the advantages previously mentioned regarding the support of the carriage below the top level of the bed are obtained. There are two lower-tier vee-ways, as shown in Fig. 4[illegible], set at different heights (by which it is claimed that twisting

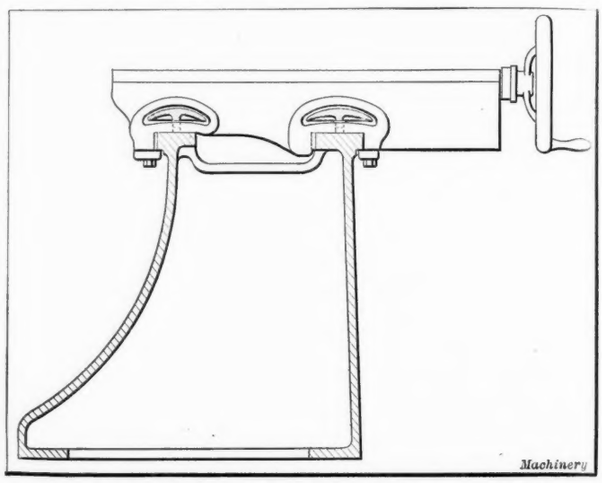


Fig. 50. John Lang & Sons' Lathe Bed with Covers over the Ways

is eliminated), and directly underneath the regular ways, so that chips cannot fall into them. The top of the bed is arranged with a vee and a flat to carry the headstock. The carriage has no bearing on the top, but only in the vee-ways.

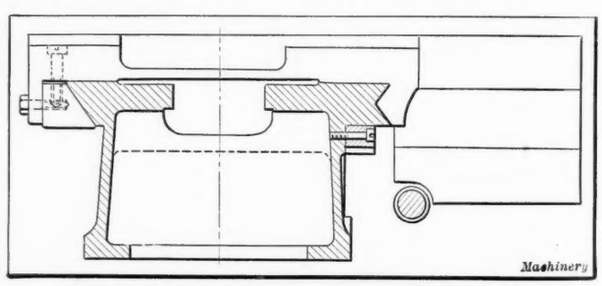


Fig. 51. Lathe Bed with Single and Double Vee-edges, built by H. Wohlenberg, Hanover, Germany

The position of the lead-screw and rack should be noted. In the lathes which have gap beds, the carriage does not overhang its supports, but is carried along by the gap on the vee-ways.

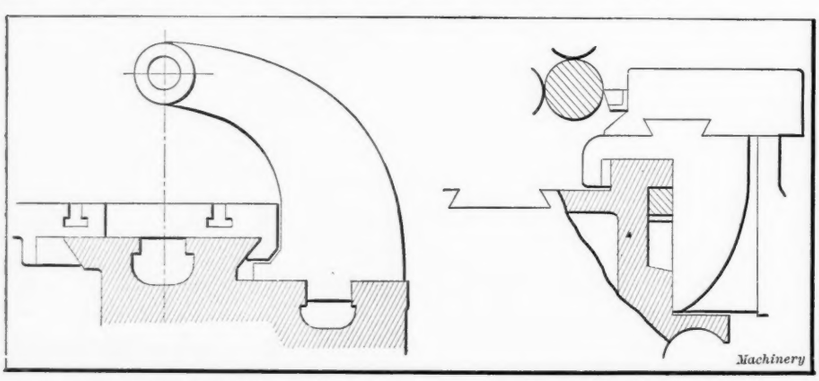


Fig. 52. Double-way Bed designed by Henry Milnes, Bradford, England

Fig. 53. The Fitchburg Design of Lathe Bed

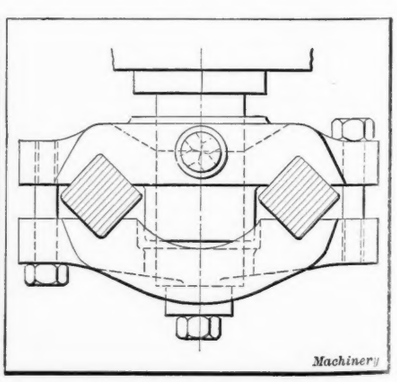


Fig. 54. The Brenot, Buronfosse & Cie Lathe Bed

A design of this kind is shown in Fig. 46, showing the construction in a lathe made by Messrs. Joshua Buckton & Co., Ltd., Leeds, England.

A different kind of lower-tier bed is made by Messrs. Drummond Brothers, Ltd., of Guildford, England. This bed is

Methods for Protecting the Ways of Lathe Beds from Chips

A few instances are met with in which lathe beds are modified specifically for the purpose of protection. The bed is either cast of such a form that the slides come below the top surface, as in the example just noted, or extra covering

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plates or guards are fitted to keep the chips away from the bearing surfaces. A bed made by the London firm George Richards, Ltd., Fig. 47, has a top portion *A* which serves as a cover over the slides, and at the same time guides the saddle at the front, forming a narrow guide between its inner face and the outer front edge of the main bed. The surfaces

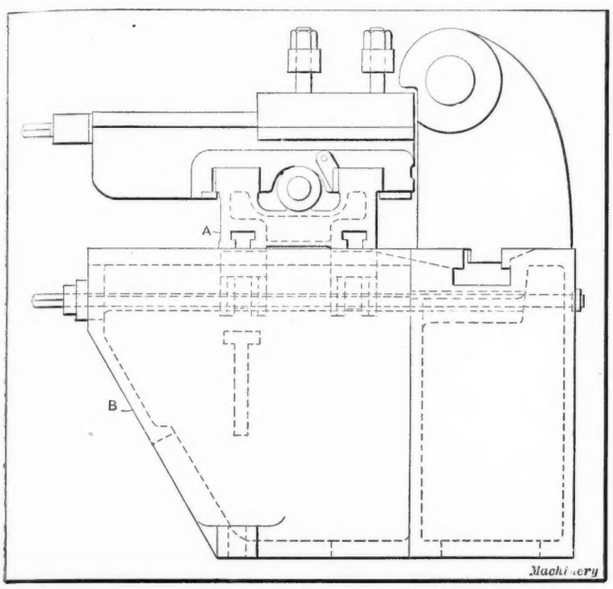

Fig. 55. The Dron & Lawson, Ltd., Glasgow, Scotland, Lathe with Extensions carrying Supplementary Bed for Carriage

B, on which the carriage slides are, therefore, absolutely protected from chips, and the lubricant does not become dirty. At the top of the portion *A* the saddle clears this casting.

Fig. 49 shows a German bed section which has the slideways arranged a little below the top surface. Steel covering plates, screwed on as guards, prevent chips from falling on to the ways. The tailstock slides on the top part of the bed, between the inner edges of the covering plates.

Messrs. John Lang & Sons build a range of surfacing and boring lathes (chucking lathes) without tailstocks, in which curved cast-iron guards, supported on short studs at each end, extend from the tail-end of the bed up to the chuck, so that chips cannot fall upon the flat ways of the bed, but are deflected by the guards and thrown off to one side. The section of a bed with its saddle cored to pass the guards, is shown in Fig. 50. It will be noticed that the saddle bears against the vertical edges of the front shear only, giving a narrow guide-way with a relation of length to width of about 7 to 1. The cross-slide (not shown) also fits on the same principle, being gibbed to the two edges of one slideway.

A rather curious type of bed is shown in Fig. 51. This type resembles an English bed at the back shear, but has a double "vertical" vee at the front edge. This lathe is made by H. Wohlenberg, of Hanover, Germany.

Double-way Type of Lathe Beds

Among the lathe beds which are made to but a limited extent are those of the double-way type, that is, beds with separate ways for the carriage and the tailstock. They are useful for work where it is required to move the carriage rapidly out of the way, and bring the tailstock up to the head without having to remove the carriage each time. The illustration Fig. 52 shows an example of this class, constructed by Henry Milnes, of Bradford, England. The tailstock slides on a back shear, below the carriage ways.

A special type of double-way bed, Fig. 55, the speciality of Messrs. Dron & Lawson, Ltd., of Glasgow, Scotland, comprises a flat-topped way carrying the tailstock, the tongue of which has a tapered adjusting strip to maintain the fit in the groove, and a loose bed *A*, resting on two extensions *B* which project from the main bed. The auxiliary bed *A* can be swivelled on the extensions for taper turning, and can be adjusted to and from the centers. The slide-rest is carried on bed *A*, and is fitted by a narrow guide at the front. The slide-rest can be moved past the tailstock, and the center of the latter need not overhang. Motion is conveyed to the screw of the slide-rest, for feeding, through a universal-joint shaft, from the gear box in front of the headstock. Graduations indicate the amount of taper when the bed is swivelled. A similar principle is employed in the Niles lathes for turning printing-press cylinders, paper-machine rolls, etc., there being car-

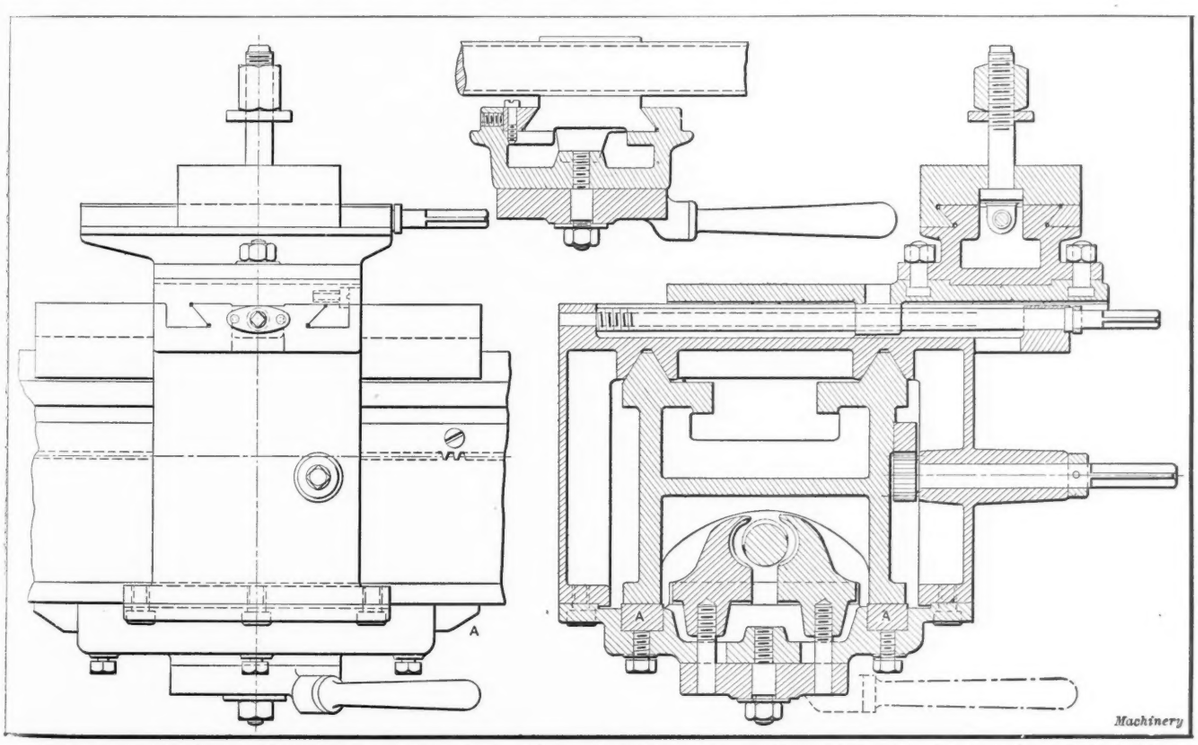

Fig. 56. An Italian Design of Lathe Bed with Gibs on Bottom Edges and Lead-screw between Shears; designed by Officine Dubosc, Turin, Italy

riages both at the back and front, sliding along supplementary beds or rails, which are themselves adjustable to and from the center.

Beds for Front-slide Type of Carriage

A special form of bed is adopted for the front-slide type of slide-rest. In this type of lathe, the carriage fits against the

front vertical face, and is retained by vees, external or internal, or by a combination of a vee and a square edge. The advantages are that the saddle can be moved past the headstock and tailstock, that it can be provided with a vertical adjustment for milling and other purposes, and that the front faces and the lead-screw are protected from injury through chips. The construction is used chiefly for precision lathes of small size. Fig. 57 shows the section of a front-slide bed built by Messrs. G. Birch & Co., of Manchester, England. The arrangement of the saddle should be noted, as well as the mechanism for elevating, which comprises a pinion and rack, the pinion being turned by a handle or by gears through a universal-joint shaft.

The bed of the Lo-swing lathe (see Fig. 53), built by the Fitchburg Machine Works, Fitchburg, Mass., is another example of a special design evolved to avoid the built-up design of slide-rest in which the horizontal tool pressure acts at a point a considerable distance above the bed which has to resist it. This lathe, made for turning bar work between centers, has the tool-holder situated but slightly above the lip of the bed which takes the pressure.

Miscellaneous Lathe Bed Constructions

Fig. 56 is another unusual design of bed, employed in some small lathes built by the Officine Dubosc, of Turin, Italy. Here the lead-screw is located within the bed. The gibs

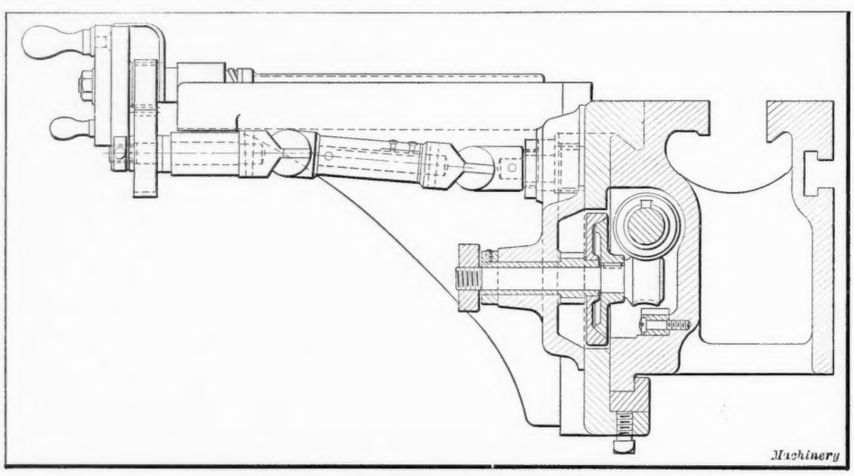

Fig. 57. Front-slide Bed of G. Birch & Co.'s Design

under the edges of the top shears are dispensed with, and their place is taken by a couple of strips *A*, pressed up by set-screws underneath the bottom edges of the two shears. This construction makes possible the half-nut arrangement shown, a cam-plate device being used for opening and closing the halves of the nut. The internal ribbing of the bed should be noticed.

As a final example of a special type of bed, the double square bar design, Fig. 54, is shown. It represents a type

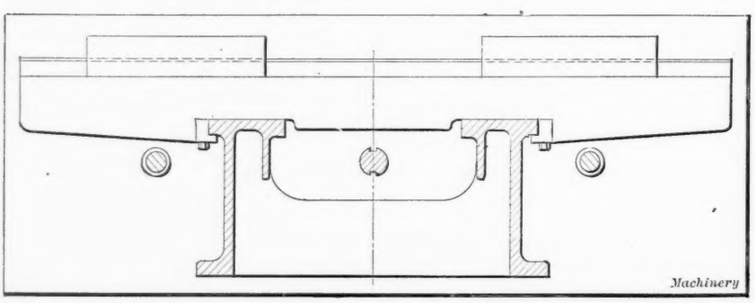

Fig. 58. Bed of Large Lathe with Internal Ribbing, as built by Hulse & Co., Manchester, England

employed in France for screw-making lathes, operated by hand, all the principal parts, including the bars, being of hardened steel and ground. The slide-rest fits on the two bars, and is slid along them by means of a lever motion. The headstock is also clamped to the bars. This lathe is made by Messrs. Brenot, Buronfosse & Cie, of Paris.

Beds for Heavy Lathes

When comparing the sectional forms of beds for large lathes with those of the ordinary type for the smaller and medium-sized lathes, the principal differences are found in the extra strengthening and stiffening of the large beds, in addition to differences in the form and number of their slideways, and in the building up and jointing of the sections, which for

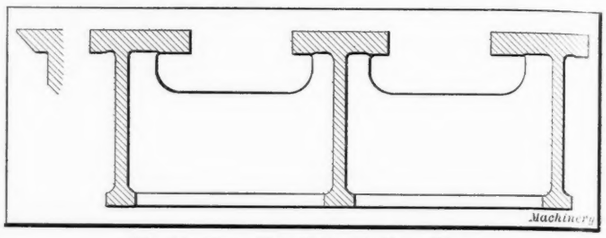

Fig. 60. Heavy Type Bed with Three Ways

manufacturing reasons sometimes take the place of a single large casting. Extra ribbing or webbing is one of the first changes introduced as the sizes of beds increase, as shown in Fig. 58, where webs are carried down on the inside from the top, and in Fig. 59, where the inner ribs completely duplicate the outer webs. Many variations of this type exist, which it is impossible to illustrate here. It may be mentioned that the bed in Fig. 58 is from a large lathe by Messrs. Hulse & Co., Ltd., of Manchester, England, provided with the firm's non-rotating twin lead-screws. There is one screw on each side of the bed, as shown, so that the saddle is propelled in a perfectly even manner, without risk of twisting.

The number of ways is increased to three, four, and even more, in large beds, according to the design of saddles employed, and their number. Three ways, as shown in Fig. 60, are frequently employed when there are independent front and rear saddles, which fit on the front and back ways, respectively and rest partly on the central one so that they may pass each other. The edges may be square or of vee form as indicated in the illustration. Beds with four slide-ways for two or more independent saddles are often used in place of the type in Fig. 60, in the larger lathes. The fitting of saddles and rests for turning large diameters on faceplate work introduces the use of wing or sole-plates, extending from the side of the main bed, or in some cases cast with it and provided with a slide-way. For certain functions, as in wheel lathes, a long cross-bed passes across in front of the faceplate, and is bolted to wings extending from the sides of the main bed. In any case, for turning large diameters, it is

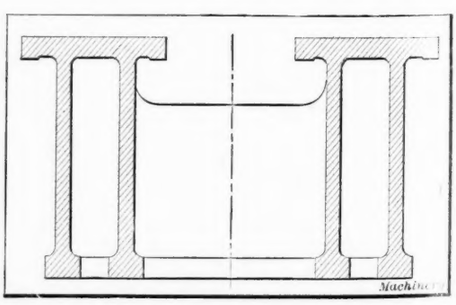

Fig. 59. Lathe Bed for Heavy Lathes with Double Webs

necessary to make the effective width of the bed sufficient to bring the tool-rests out to the required radius.

In some types of lathes for facing only, there is no bed at all, but only a stand to carry the headstock, and a tee-slotted plate in front of this, which has no slide-ways, but which simply supports the tool-rest.

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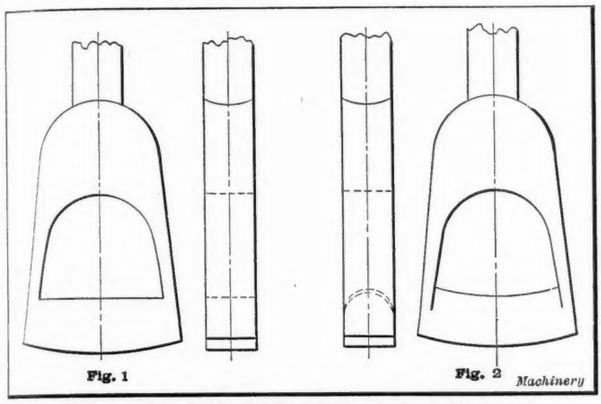
SPADE-HANDLE FORMING MACHINE

By FRANK W. SPENCER*

Some time ago the writer had occasion to design a machine for forming or shaping the "grips" of ordinary spade handles. Figs. 1 and 2 show the handle before and after being shaped.



Figs. 1 and 2. Spade Handle before and after being formed

Formerly these handles were shaped by hand with a spokeshave, and although they were finished by this method in fairly good time, it was thought that the work could be done more cheaply and the handles be made more uniform in shape by using a properly designed machine.

Fig. 3 shows front, side and rear elevations of the machine used for this purpose. As will be seen, it bears a rather striking resemblance to a milling machine. The inside of the handle is finished by a double-edged cutter of the proper radius, which is mounted in the holder *A*. This holder is carried by arm *B*, which is given an oscillating motion by a crank mechanism at the rear of the machine. The holder, which is shown in detail in Fig. 5, is not held rigidly in arm *B*, but is allowed a slight oscillating movement independent of the arm, which permits the cutter to tip over slightly at the end of each stroke, so as to bring the opposite cutting edge into the working position. This tipping movement is controlled by set-screws which come in contact with a dog on the rear of the holder (as shown in the front and rear detail views, Figs. 6 and 7) thus limiting the amount that the cutter is inclined in relation to the work.

In the operation of the machine, the spade handle is slipped over the cutter and clamped in a vise. The operator then engages driving pulley *C* with the crankshaft by means of a friction clutch *D* which is controlled by the foot-treadle shown. The handle is fed upward against the oscillating cutter by the handwheel seen at the front of the machine. As the cutting edge of the cutter is about one-half inch below the axis of the holder, as shown in Fig. 5, the edge on the leading side is automatically kept in the working position. For example, when the arm swings to the right, the right-hand edge is in action and when the movement is reversed, holder *A* automatically tilts and brings the left-hand edge into the working position. This simple arrangement enables a clean cut to be taken right up to the corners of the handle. The friction clutch *D* is double-ended and when the foot-treadle is released for stopping the machine, the rear end of the clutch automatically engages a stationary cone, which acts as a brake and instantly stops the oscillating movement. This feature enables the operator to remove the finished handle and insert a rough blank without loss of time owing to the machine's continued movement due to momentum. This engagement of

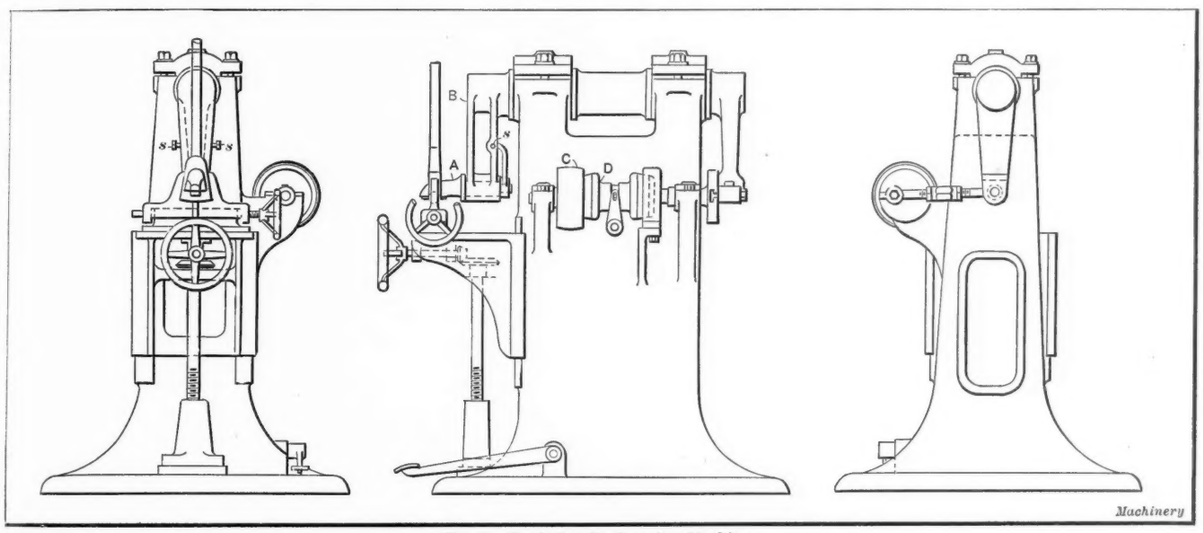


Fig. 3. Spade-handle Forming Machine

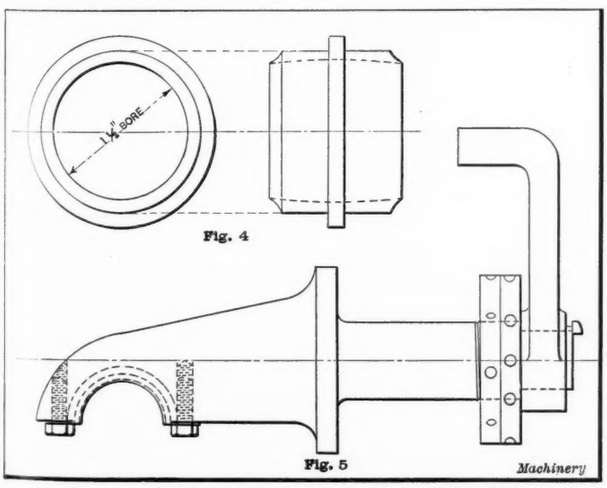
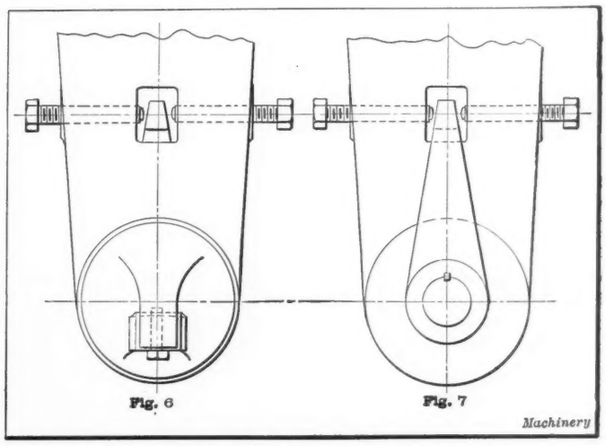


Fig. 4. Method of making Cutters. Fig. 5. Cutter Holder



Figs. 6 and 7. Front and Rear Views of Cutter Holder and Mounting

* Address: 183 Javin Hill Ave., Dorchester, Mass.

the clutch with the stationary cone is effected by a spring located inside the base.

The first cutter that was made for this machine was forged and then filed and ground to the proper shape, but this required too much time and was too expensive. The method now employed is indicated in Fig. 4. A piece of tool steel is bored and turned to the cylindrical shape shown, and this shell is then sawed in half, thus forming two cutters, which are ready for the machine after being hardened and tempered. The annular projection or shoulder formed on the back of each cutter fits into a recess in the holder and takes all the cutting strain, thereby relieving the retaining set-screws.

* * *

REMARKS BY THE ONLOOKER

Nothing illustrates to my mind more clearly how gear cutting has been improved in the last few years than the construction of the high-duty lathe shown on page 395 in the January number of MACHINERY, engineering edition. Many of the readers no doubt recall the warning of the boss in past years when a specially fine job was wanted, *viz.*, "Don't use the back-gear," and there was a reason. The lathe referred to is nothing but gears in the headstock and the work from it is not complained of, which goes to show that gear cutting is now a fine art. Still the old desire for a cone drive is evinced by the fact that the American Tool Works states that it is also making this with the cone drive. I recall a story which the illustration of the lathe suggests of a somewhat "overtook" machinist who had applied for a job and had been told to take off his coat and get busy on a lathe pointed to. The man eyed the tool a moment and then said, "Say boss I said I was a machinist, not a blamed organ player. What in h— is all them handles for?"

The making of steel stamping dies as described by Mr. Lucas is interesting. I wish there were some way to teach the average machinist how to use steel stamping letters and figures on machine parts so that they would not have the appearance of having had "a night off." Very often the appearance of a fine piece of work is spoiled by slovenly marking. I suggest that the figures and letters have their sides machined with the figure or letter as the center. Then by the use of a straight-edge and spacers, much better work could be done by the average machinist. The letters as now made are not always central with the body, and it is difficult for a man to estimate just how he should hold the letter to get true alignment. One of the hard things to do in a shop is to make the boss believe that a set of letters or figures ever wears out, gets broken or lost. Referring to the illustration Fig. 10, of the article, I am moved to say that perhaps times have changed. If I had filed with my forefinger, as shown, when serving my apprenticeship, it would have been unhealthy. My boss has a trick of whacking a fore-finger so placed, and I learned my lesson with the first whack, as it was a cold morning.

"Ex-toolmaker" makes some statements which I cannot accept. I know that there are many more expert machinists and toolmakers now than there were twenty years ago, and I will go farther and say that there are better men at work today than then. Fine work was done then, but it is now done more accurately and in very much less time. The fact overlooked by "Ex-toolmaker" is that there are many more people employing the skilled man now than there were twenty years ago. Just why it is not wrong to "time clock" a man who cannot read, and wrong to excuse a man who can read, is not clear to me. The statement that the average proprietor does not recognize the distinction between skilled and unskilled mechanics will not stand investigation. The proprietor is recognizing this all over the country by paying toolmakers considerably more than automatic machine tenders. I frankly admit that the distribution of wages is not fair. We now overpay the poor workman and underpay the good workman. This fact discourages the skilled man, and I think is more likely to be the reason, if there is a single reason, for his wanting to get out of the trade than what "Ex-toolmaker" suggests. The poor machinist has got into the wrong place; he might have made a very good tailor or bookkeeper, but he made a bad choice to the detriment of all concerned. The average manufacturer and all large establishments do not put their office help on honor, but use a time clock, and we read that at the Bethlehem Steel Co.'s works the president, Mr. Charles M. Schwab, is on the time clock the same as the rest of the employes. Just who is to call him down if his punching is not up to the standard, I have not found out.

The crankpin turning machine shown is very interesting to me, on account of the "full width" chip. I suppose the machine described by Mr. Perkins, and the one referred to by "Nomad" are the same. In grinding, Mr. Norton has shown the advantage of "full width" work, but I am not at all willing to accept the assertion that rapid and accurate work can be accomplished by the machine described. I will admit the rapid part, but when it comes to the accuracy, I balk. Ounces or even pounds of metal are being removed, to grains when grinding, and that is quite a different matter when accuracy is the object. I should say that a combination of the crankpin turning machine and a modern grinding machine would give very satisfactory commercial results.

I was delighted to read the "Chordals Letters" extract in your editorial. There seems to be a curious idea abroad that by the juggling of a name, great results will follow. "Scientific nonsense" would be the right term for a large amount of half-baked work now being done under the guise of scientific management. Strip it of all wordiness and put it in plain language, and Chordal's story simply tells of common sense, as useful in the machine shops as anywhere.

The gas engine industry referred to in the editorial on farm work is a great coming one, and one which has not far to come either. In fact, it is here and is only kept from a far larger development for the reason that, as yet, the cause of an internal combustion engine's doings, or rather misdoings, have to be searched for and found by elimination. When these troubles can be accounted for and found as easily as can those afflicting the steam engine, the greatest obstacle to the universal use of gas engines will be removed.

If I were to expand on automatic *vs.* hand machines, there would not be room enough in your total next year's issues to print what I would have to say. It is one of the most interesting topics of the day. "I ride with you" for a certain distance in your remarks, but jump right off when you introduce the idea that automatic machines and manufacturing are more closely allied than making or building machinery. While the saving is great in manufacturing, I believe it can be made greater in building, *i. e.*, making a single article. This perhaps will not be believed and should not be without further evidence, but let me cite a case. A Jones & Lamson flat turret lathe, will in many cases, turn out a single piece at as low a cost as any engine lathe, provided equally skilled men are employed. It will turn out half a dozen pieces at a very much lower cost than the engine lathe, but neither can do two operations at the same time, so there are a lot of possibilities loafing most of the time. If we had machine tools of one function only, cheap and substantial, they could do one operation far more efficiently and rapidly, and many operations could go on at the same time with a distinct gain. So I say, make tools of single functions only, like a thread miller, with a fair range of capacity. While the thread miller is cutting the thread, a blank is being turned in another machine, and so on. These machines should be so designed that they have one function only, which cannot be changed. I paraphrase your last paragraph in the editorial by saying: "Provide machines of single function with a reasonable range of work, and get over the idea that it is wise to buy a hay rake, a stove lifter and a milking stool all in one." I suppose this will stir up somebody who knows a lot more than I do on the subject, and who does not believe a word I say.

The heavy outlining of a machine tool as shown on page 399 seems to me a very good idea if it helps to carry the general form better in the mind and makes the tools seem alive, and thus helps the salesman. Right here can be taken up the question that "L" and Prof. Cardullo are considering: "how best to get rid of what you make." It is the burning question with all tool builders. It seems to me self-evident that the first step is to let the world know that you have something to sell and what it is. The pages of a recognized trade journal

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are the best medium to distribute the knowledge you want people to have, and there is where machinery people look for information in their line. The man who gets rid of the goods is the "king pin," and what he is paid must bear the same proportion to returns as in any other department.

The article on "Herringbone Gears," by Mr. Day is very instructive, and the pith of the entire article is embraced in his assertion: "Herringbone gears completely overcome all these difficulties, but only when they are accurately cut," and there is the rub. On small sizes of herringbone gears I have had little trouble, but on large sizes I have had a great deal.

The briquetting of metal borings is something to think about, but at first sight the question suggests itself, whether the result justifies the expense saved in very large works. I wonder if an inexpensive machine for small shops would not sell well? As it is now, the steel chips take up a lot of room and are often depreciated in value by being thrown out in the weather. The briquetting system would save room, but it might not show much profit.

I am a crank on small tools, and what I mean is, I believe there is no more fruitful source of loss than making small tools in the shop instead of buying them from the manufacturers who specialize on small tools. The counterbore made by the National Tool Company is an example. Here a carefully considered design is produced and made by those who are skilled in that class of work and standard sizes are provided. The cost of each is less than that of a drawing for a special counterbore. There are many other small tools which are better bought than made, and I blame the small tool people to a large extent because they do not advertise more what is available. There is a general feeling that such tools cost a lot simply because the cost is at once before the eye, while to have Bill make the counterbore covers up the cost for a time at least, and anyway it can be "run in on a job." We have it from a prominent man lately that dynamite "always acts downward." The ability to see a hole in the ground and the inability to see a hole in the air accounts for his utterance. Making small tools at home and considering it a money-saving proposition is on a par with the dynamite idea.—W. D. F.

* * *

MAKING A FERRULE IN ONE OPERATION

By THOMAS ALMA

The accompanying engravings illustrate a ferrule and the method of blanking, drawing, redrawing and finishing the hole in the bottom, in one operation. The die, which is shown in Fig. 1, is not a complicated one, nor is it difficult to construct. That it is practical is obvious from the fact that it is producing ferrules at the rate of 1080 per hour. This shows the possibility of combining several operations in one.

The punches and dies were made of 0.120 point carbon steel, and used in a No. 3½ Bliss double-acting press. This press was used because there was no smaller press available in which the dies could be used. The tools, on account of their small size, were made from bar stock, but in general, drawing punches and dies, except for small work, should be made either of cast iron or cast steel. In some cases a cast-iron die is just as efficient as one made of tool steel. It is the writer's practice to make a pattern and cast the die, punch or blank-holder as nearly to size as possible, thus dispensing with the machining and bench work. In making this die, the first thing done by the bench-hand was to make male and female sheet-metal gages, about 1/16 inch thick. These gages must be full size, not half gage, as it is very easy for a lathe-hand to misread his micrometer one turn, 0.025 inch, but there is no excuse for a workman not making a part right when he has gages to work to, and, moreover, it is quicker to work to the gages.

This set of tools, as can be seen at a glance, requires only straight lathe and grinder work; therefore, after the bench-hand had made the templets, he had no more to do with the tools until they were turned, hardened and ground and came back to be assembled. The cutting punch was only hardened on the end, leaving the shoulder soft, thus making it possible to get a perfect alignment for the two ⅝-inch sub-press pins, after the die and punch were hardened and ground. The blanking die, as well as the first and second drawing dies, had to be true with the outside diameter, as each in turn was recessed out for the other. Thus it was a simple matter to assemble the die. It was also certain to be in line with the re-punching punch, provided the cast-iron die-holder

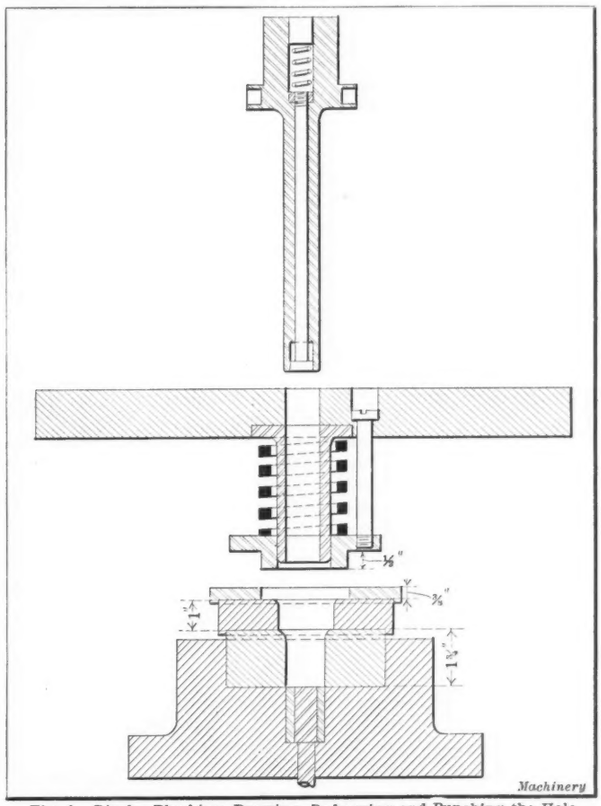

Fig. 1. Die for Blanking, Drawing, Redrawing and Punching the Hole in a Ferrule in One Operation

was bored out complete at one setting. Alignment is very essential on this kind of a tool. The blanking, first drawing punch, and extreme end of the second drawing punch all have to be ground true with the outside diameter.

The second operation drawing punch, which is also the re-punching die, is provided with a spring stripper. This stripper has a rod passing through the punch, held in place

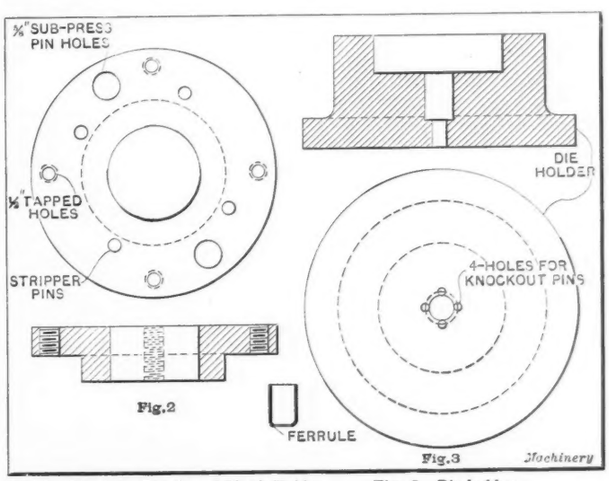

Fig. 2. Blanking Punch and Blank Holder Fig. 3. Die-holder

by a nut. Behind the stripper is a spiral spring, held in place by a blind screw. Six 5/16-inch holes are drilled in the shoulder of this punch, for holding the punch to the ram of the press. By making the spring stripper in this manner, the scrap from the ¾-inch hole in the bottom of the ferrule is retained on the inside of the shell when it is ejected. The spring stripper which operates the blanking punch is turned down, so as to take up as little room as possible. Figs. 2 and 3 show the construction of the blanking punch and the die-holder, respectively.

MAGAZINE ATTACHMENTS—1

APPLICATION TO THE BROWN & SHARPE AUTOMATIC SCREW MACHINES

By DOUGLAS T. HAMILTON*

In addition to the milling, cross-drilling and burring attachments which were described in MACHINERY from September to December, 1911, inclusive, the Brown & Sharpe Mfg. Co. has also designed a number of magazine attachments, both of special and standard nature. Most of these attachments are held on the same bracket as the milling, cross-drilling and burring attachments, etc., and are removed in a similar manner. Some of the attachments are fed by hand while others are semi-automatic in their operation. All that is necessary in the way of operating is to dump the parts on which a second operation is to be performed into the hopper, from which they are transferred to the chuck. The chief value of a magazine attachment is that it facilitates the handling of parts, such as are shown in Fig. 9, which have to be operated upon on both ends, thus necessitating re-chucking.

Magazine Attachments for Handling Plain Cylindrical Work

A magazine attachment used for handling plain cylindrical pieces on the No. 00 Brown & Sharpe automatic screw machine, which is made adjustable and fed by hand, is shown in Fig. 1. This attachment consists mainly of a movable

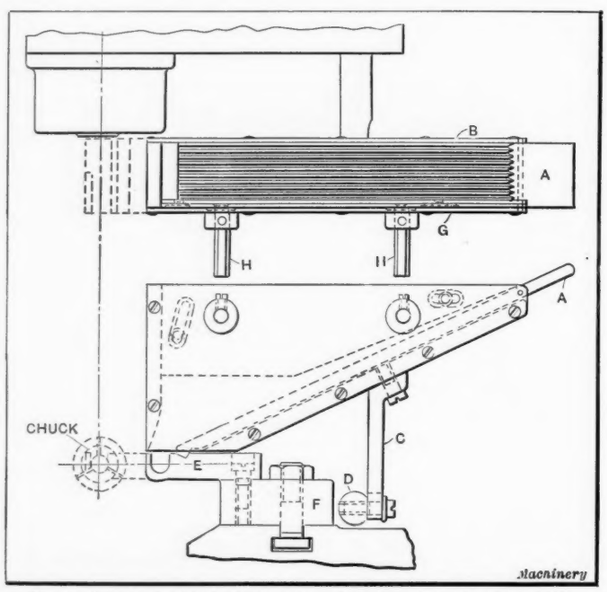

Fig. 1. Standard Adjustable Magazine Attachment for Handling Plain Cylindrical Pieces on the No. 00 B. & S. Automatic Screw Machine

slide *A* pivotally connected to the two sides *B* and *G* of the trough. The slide *A* is corrugated on its top face to reduce its frictional resistance to the work, and rests in a V-groove in the carrier *E*. When the cross-slide is in its "back" position it is moved back and forth (by small lobes on the cross-slide cam), so that the slide *A* is raised and lowered to prevent the work from cramping in the trough. The trough is supported by a bracket *C* fastened to the pin *D*, which acts

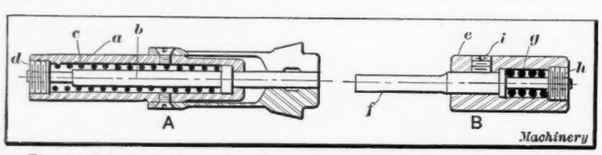

Fig. 2. Spring Collet and Work Inserter used in Connection with the Magazine Attachment shown in Fig. 1

as a stop for the cross-slide. The carrier *E*, which removes the work from the chute to the chuck, as shown by the dotted lines, is fastened to a block *F* held to the cross-slide by means of a tee-bolt and nut as shown. The plate or side *G* is adjustable on the studs *H*.

The work is forced out of the carrier *E* into the chuck shown at *A* in Fig. 2 by the plunger, shown at *B*, which is held in the turret. The chuck is provided with a work-ejecting mechanism consisting of a sleeve *a* held in the chuck by two flat-headed screws. Inside of the sleeve is a rod *b* operated upon by a spring *c*. A hollow nut *d* is screwed into the rear end of the sleeve *a* to prevent the spring from coming out. The plunger or work-inserter shown at *B* consists of a sleeve *e*, fitting the hole in the turret and bored out to receive the plunger *f*. This plunger is operated upon by a spring *g* held in the body by a nut *h*. A set-screw *i* is provided to prevent the plunger *f* from turning when it is of flat cross-section, thus holding it in the correct relation to the hole in the chuck.

In operation, as the piece comes down the slide of the magazine attachment shown in Fig. 1, the turret is advanced, and the inserter, shown at *B* in Fig. 2, forces the work out of the carrier into the chuck, and pushes the plunger *b*, in the chuck, back against the tension of the spring until the shoulder on the plunger butts against the stop-nut *d*. The chuck is then closed and the turret drops back. When the operations on the piece are completed, the chuck is opened and the spring *c*, which has been compressed, ejects the piece from the chuck.

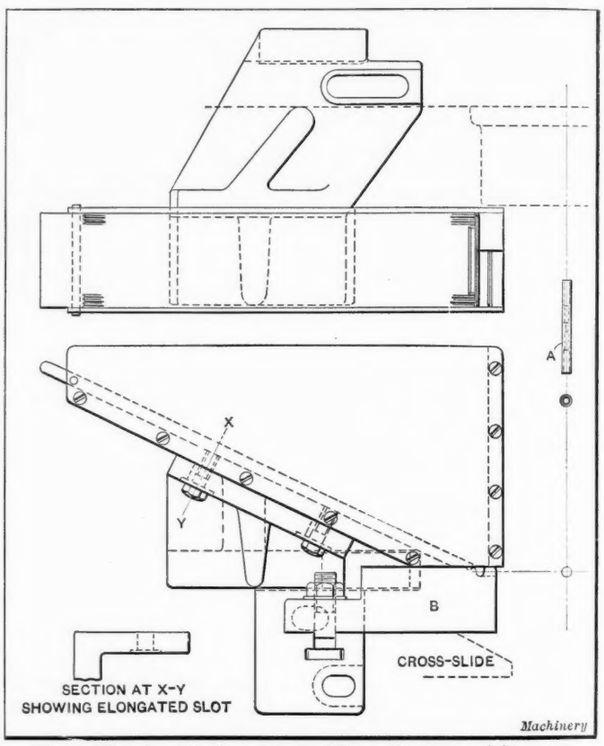

Fig. 3. Magazine Attachment for Handling a Counterbored Sleeve on the No. 2 Brown & Sharpe Automatic Screw Machine

A magazine attachment somewhat similar in construction to that shown in Fig. 1, but which is not adjustable, is shown in Fig. 3. This attachment is used on a No. 2 Brown & Sharpe automatic screw machine for handling the counterbored sleeve shown at *A*, Fig. 3, and also at *G* in Fig. 9. The work-carrier *B* is fastened to the front cross-slide and is provided with a circular groove for holding the work. The slide is corrugated and fastened to a bracket as shown. The work is held in a chuck, when being operated upon, and inserted the same as in the previous case.

In Fig. 4 is shown a magazine attachment for handling headed bushings, two of which appear on the table. The attachment proper is fastened to a bracket by cap-screws, and is built up of two strips *A*, held apart by blocks *B*. A slot fitting the head of the bushing is cut in each strip so that the work can only be placed in the slide with the head facing the turret. The chuck is provided with a spring-actuated inserter *C* held in the turret. The work-carrier *D* used on this attachment differs in construction from that previously shown, as it is necessary to open it before the work can be inserted in the chuck because of the shoulder on the work.

* Associate Editor of MACHINERY.

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The construction of this type of work-carrier is more clearly shown in Fig. 5.

Magazine Attachment for Holding a Safety Razor Handle

The safety razor handle shown at *A* and *B* in Fig. 5, and also at *A* and *B* in Fig. 9, which is used on the famous Gillette safety razor, is finished in the Brown & Sharpe automatic screw machines. The first operation consists in turning, forming, knurling, drilling and tapping one end, and cutting off, producing a piece as shown at *A* in Fig. 5. Then the handle is taken to another machine and put in the slide of the attachment shown in the illustration, fed to the chuck, and a hole is drilled clear through the handle, and one end is bell-mouthed.

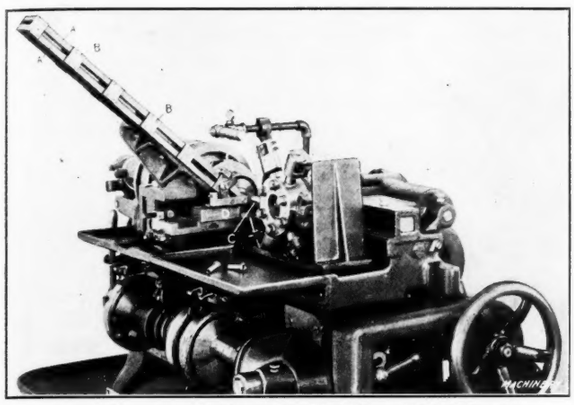

Fig. 4. Magazine Attachment for Handling a Headed Bushing

The top and bottom plates *C* of the slide are milled to suit the shape of the handle, and as it is provided with a shoulder,

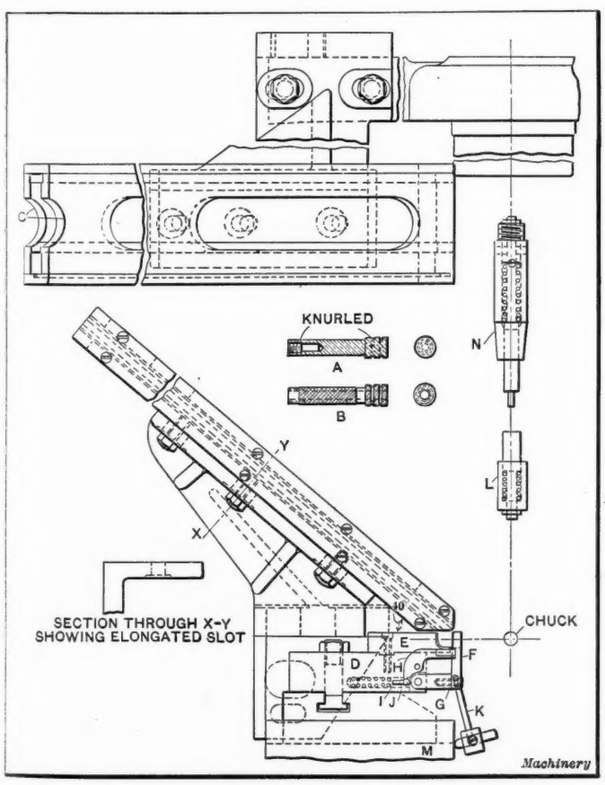

Fig. 5. Magazine Attachment for Handling a Safety Razor Handle on a No. 0 Brown & Sharpe Automatic Screw Machine

some means must be adopted for opening the work-carrier to eject the piece. The work-carrier consists principally of two blocks *D* and *E* and a finger *F*. Block *D* is held to the cross-slide, while block *E* is fastened to the top face of block *D*. The forward end of block *E* is cut out to fit the work, which is held in place by the finger *F*. This finger is fastened to a lever *G*, pivoted on block *D*, and prevented from swinging by a pawl *H*, acted upon by plunger *I* and pin *J*.

The operation of this work-carrier is as follows: When the piece drops into the pocket in the block *E* and the front cross-slide advances until the work is in line with the hole in the chuck, the large part of the inserter *L* trips the finger *F* after the work has been partly inserted. This action is accomplished by the inserter *L* coming in contact with the beveled edge of the pawl *H*, removing the V-shaped end of the pawl from the groove in the lever *G* and at the same time pushing back the spring plunger *I*, thus allowing the finger *F* to drop away from the block *E*. The pawl *H* acts as a locater for the work to keep it from sliding out of the pocket, and as it is disconnected from the lever *G*, it drops down swinging on the pivot shown, so that the work can be inserted into the chuck by the plunger *L* which is held in the turret.

After the work has been inserted in the chuck, the cross-slide, in dropping back, brings the trip *K* against the casting *M*, which through the combined action of lever *G*, pawl *H* and spring plunger *I* closes the work-carrier. The work is

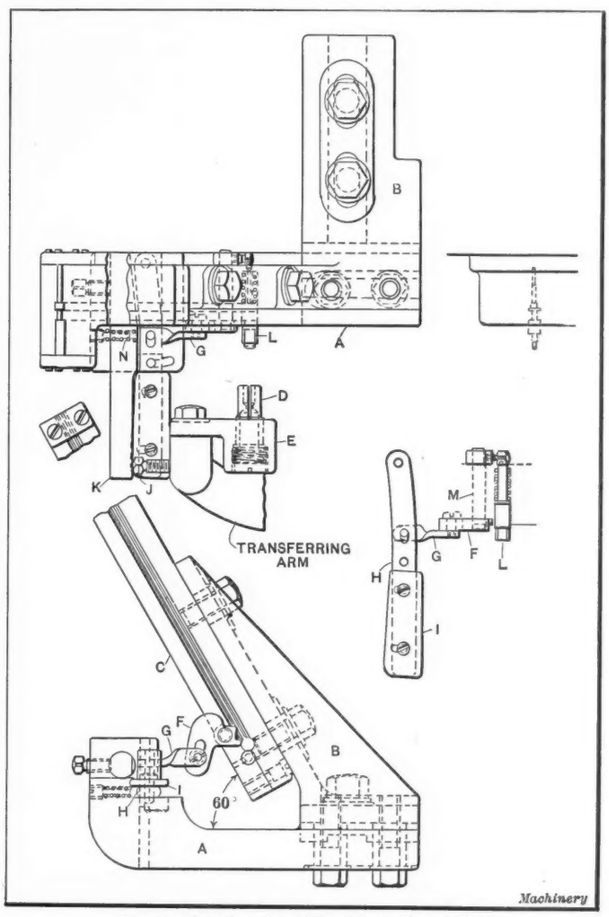

Fig. 6. Magazine Attachment for a Pinion Staff

forced into the chuck against a spring plunger which is held in the feed finger *N*. This spring plunger ejects the work when the chuck is opened. Another piece of work, which is handled in an attachment similar to that shown in Fig. 5, appears at *H* and *I* in Fig. 9.

Magazine Attachment for Handling a Pinion Staff

A magazine attachment which differs in design somewhat from those previously shown is illustrated in Fig. 6. This attachment was designed for handling the pinion staff shown by the heavy dotted lines in the illustration. The magazine attachment consists mainly of two brackets *A* and *B* and a slide or chute *C*. The bracket *A* is fastened to the bracket *B*, which is held to the boss provided on the Brown & Sharpe automatic screw machines for holding special attachments. The chute *C* is made in two parts, which are held together by blocks as shown, and is cut out to fit the blank so that it is impossible for the latter to be located except in the correct position. The blank is removed from the slide by means of a special transferring bushing *D*, split, spring-tempered, and free to slide in the transferring arm block.

The transferring block *E* is counterbored and tapped to receive a coil spring and nut for holding it.

The operation of this attachment is as follows: As the work comes down the chute *C*, it is arrested by means of the upper projection on the trip *F* which is connected to a link *G*. Link *G*, in turn, has a pin in it which works in a slot cut in the lever *H*. Lever *H* has fastened to its top face, a trip lever plate *I*, which can be set at the required angle and then held by means of the screws shown. Now when the transferring arm ascends, it is stopped in the correct position by means of a set-screw *J*, which comes against the stop *K*, the arm itself bearing against the trip lever plate *I*, and forcing it back. This action, through the lever *H* and connecting link *G*, operates the trip *F*, allowing one piece to drop into the pocket cut in it. As the arm is advanced, the bushing, in being forced over the work, pushes back the nest *L*, allowing the work to be inserted in the transferring bushing *D*. The construction of this lever arrangement for

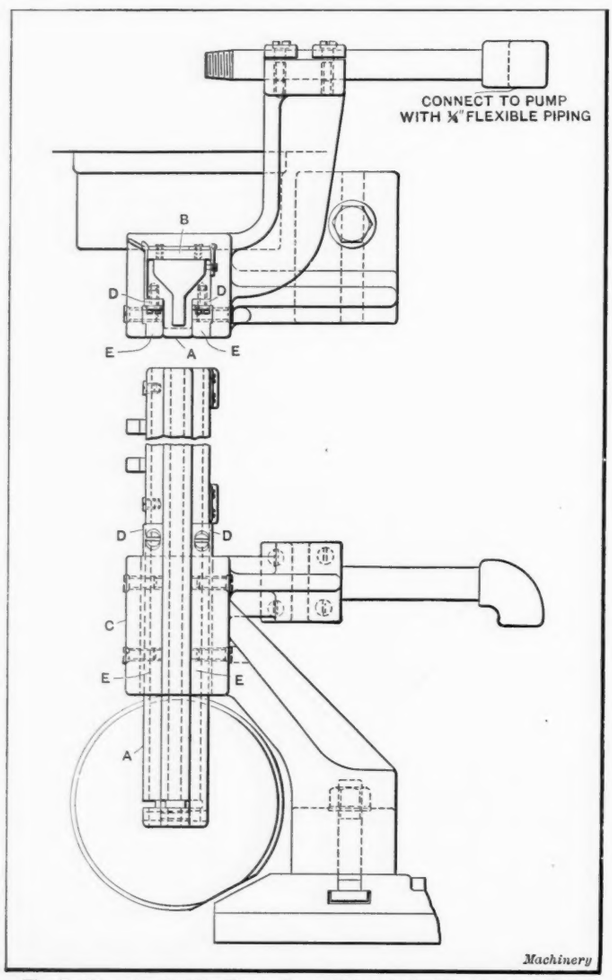

Fig. 7. Magazine for Handling a Brass Yoke blanked in the Punch Press

allowing only one piece to drop down at a time is more clearly shown in the part detailed view to the right of the illustration. Here it can be seen that the work-trip *F* is fulcrumed on a stud *M*, passing through the slide *C* and retained by means of a washer and set-screw.

After the work is inserted in the bushing *D*, the arm backs away from the nest *L* and then descends to the work-chuck. Upon the descent of the transferring arm to the work-chuck, the spring *N* returns the trip lever plate *I* and lever *H* to their former position. This action, through the connecting link *G*, rotates the trip *F* back into position to catch another piece, the piece in the trip being deposited in the nest *L* ready to be transferred to the wood-chuck.

Magazine Attachment for Handling Parts Blanked in the Punch Press

Ordinarily, parts which are blanked out in the punch press and require a machining operation to complete them, are handled in a hand screw machine or turret lathe. In the majority of cases, however, where a large number of parts are required, it is advisable to use an automatic screw machine equipped with a magazine attachment. Good examples of this class of work are shown at *C*, *D*, *E*, *F* and *P* in Fig. 9. The magazine attachment for handling the piece shown at *C* is illustrated in Fig. 7. The shank of this piece is to be turned cylindrical and to an exact diameter.

Referring to Fig. 7, it will be noted that this magazine attachment consists primarily of a box-shaped slide *A*, pro-

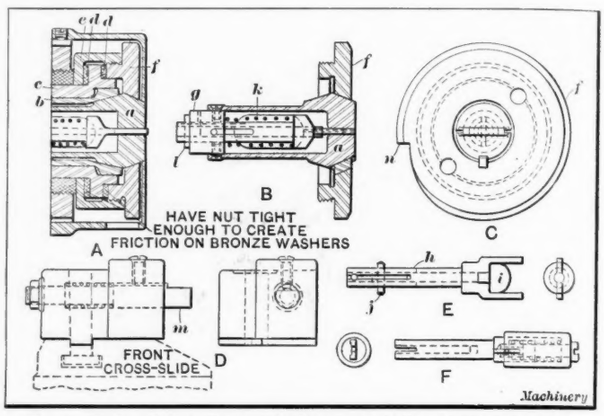

Fig. 8. Spring Collet, Cross-slide Stop for Spindle and Work Inserter used in Connection with the Attachment shown in Fig. 7

vided with a swinging door *B*, which allows the pieces to be placed in the chute. The slide *A* is held in a vertical position, which is preferable for flat stock, in a bracket *C* provided with two arms, one of which is fastened to the rear cross-slide, and the other to the oil feed tube. The cross-slide is advanced by the cross-slide cam to bring the chute into position in front of the chuck for inserting the work.

The slide *A* is milled out to suit the shape of the work and has two adjustable blocks *D* fastened to it, which rest on the top face of the bracket *C*. These blocks hold the slide so that the slot in the lower end will be in line with the chuck. Two blocks *E* are fastened to the bracket *C* by screws, as shown, acting as a locater for the slide. This slide is made long enough to hold 104 blanks and it requires approximately twenty minutes to empty it. Two slides similar to the one shown in the illustration are made, so that when one is empty, a full one can be put in place without stopping the machine. The slide is removed by simply pulling it up out of the bracket.

In turning down a piece of flat stock similar to that handled in this attachment, it is necessary that the chuck should be stopped in a certain relative position each time a piece is to be inserted. The chuck for holding the punching shown at *C*,

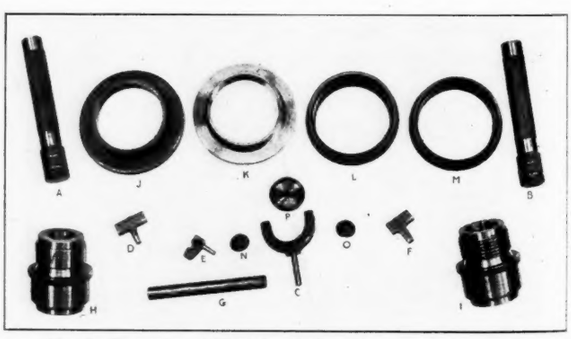

Fig. 9. Examples of Work handled in Magazine Attachments

Fig. 9, and the parts used in connection with it are shown in Fig. 8. At *A*, the chuck *a* is shown inside the special sleeve *b*, the latter being inserted in the special spindle *c*, provided with a shoulder, on each side of which are located bronze friction washers *d*. A hollow nut *e* is located in the intervening space between the rear bronze washer *d* and the bronze bearing in the front box of the machine. Screwed into the front end of this hollow nut *e* is a special nut *f*, which holds the chuck *a* in the sleeve. This nut fits the taper on the front end of

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the chuck and is keyed to the latter, as shown at *B*, the reason for which will be explained later. The manner in which the nut *f* is keyed to the chuck *a* is shown at *B*, where the construction of the ejecting plunger and stop is also shown.

The chuck *a*, as shown at *B* and *C* in Fig. 8, is broached out to suit the shape of the piece shown at *C* in Fig. 9. This chuck is also slotted and spring-tempered, the same as the ordinary spring collet. The ejecting mechanism and stop are held in a bushing *g*, which is secured in the rear end of the chuck by means of two flat-headed screws, as shown. The ejecting plunger *h*, shown in detail at *E* in Fig. 8, consists of a cylindrical body with a hole drilled through it to suit the stop *i*. The front end of the ejector *h* is milled down so that it will slide freely in the elongated hole in the chuck and is provided with a keyway in which a pin held in the bushing *g* works. The stop *i*, which is flattened on the end, is held in the correct relation to the ejector *h* by means of a pin, driven into it, sliding in an elongated hole in the ejector. This pin *j* passes completely through the stop *i*, ejector *h*, and sleeve *g*. The ejector *h* is kept out by means of a coil spring *k* and is retained by a pin *l*. The work is forced into the chuck by means of an inserter, the construction of which is clearly shown at *F* in the illustration.

In operation, the automatic screw machine is provided with one loose and one tight belt. The tight belt is used to drive the machine when turning the piece, while the loose belt is placed on the cone to which the clutch is connected when it is

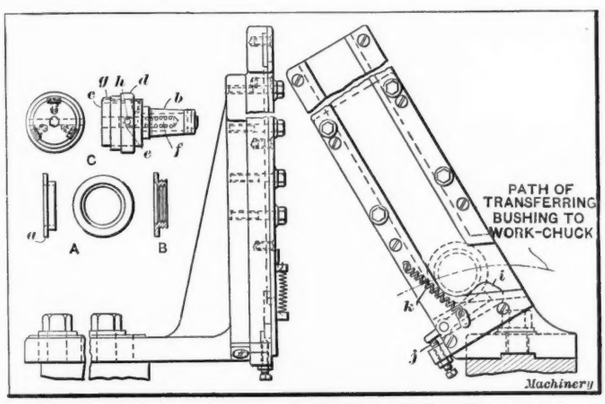


Fig. 10. Magazine Attachment for Handling a Hollow Nut, blanked and drawn-up in the Punch Press

desired to stop the rotation of the spindle. The clutch is operated by the dogs provided on the drum on the front camshaft, when it is desired to stop the rotation of the spindle, and the front cross-slide is advanced bringing the plunger or stop *m*, shown at *D* in contact with nut *f*. This spring plunger locates beneath the ledge *n* and as the belt, which is now driving the spindle, is running loose, the rotation of the spindle is easily stopped. However, if this stop alone were depended upon, it would cause excessive jar, so that it is necessary to have the bronze frictional washers *d* interposed between the nut and the spindle. The nut *f* is tight enough to create a friction on the bronze washers sufficient to drive the work when turning.

The pieces shown at *D*, *E*, and *F* in Fig. 9 are handled in a magazine attachment similar to that shown in Fig. 7, and are held in a chuck of a similar design to that shown in Fig. 8. The ejecting mechanism, inserter, etc., used are also of the type illustrated in Fig. 8.

Magazine Attachment for Handling a Hollow Brass Nut

The hollow brass nut shown at *J* and *K* in Fig. 9 is a punch press product, as are also the parts shown at *L* and *M*. The piece shown at *J* is first blanked and then drawn up into the shape shown, in the punch press. The magazine attachment for handling this piece is shown in Fig. 10, where the work is also shown before and after completion at *A* and *B*, respectively. The same type of attachment is used for handling the pieces shown at *L* and *M*. This hollow nut requires two handlings after it leaves the punch press. In the first operation the rim *a*, shown at *A*, is turned, while in the second operation the outside and inside are turned and threaded and the rim faced. The same attachment is used for both operations.

This attachment is comparatively simple in operation and is located on the boss used in holding the milling, cross-drilling and burring attachments. The work is removed from the attachment by a holder shown at *C* which is held in the transferring arm. This holder is provided with a taper shank *b*, fitting the main body *c*. On this body *c* is held a ring *d*, through which a pin is driven. The pin *h* in this ring *d* fits in an elongated hole in the body *c* and is driven into the spring plunger *e*. The main body *c* is retained in the bushing *b* by means of a collar and pin as shown. The body is provided with a slot in which a flat spring *g* is held with a screw. This spring is furnished so that the work will be gripped securely. It also makes provision for slight changes in the diameter of the hole in the work. When the transferring arm is advanced, the work is forced onto the body *c* against the ring *d*. Now when the transferring arm descends to a position in line with the chuck and is advanced, the work is placed in the chuck. The transferring arm advances until the pin *h* comes against the rear end of the elongated slot in the body *c*, when further movement of the collar is arrested and the work is placed firmly against the shoulder in the chuck.

These hollow nuts are placed in the slide of the magazine attachment by the operator and as they drop down are retained by means of a finger *i* provided with two surfaces of different heights. The rear end of this finger *i* is held firmly against a set-screw *j* by means of a coil spring *k*, provided with a lock-nut. As the work is gripped by the work-holder, held in the transferring arm, and as the latter descends towards the chuck, the finger *i* is depressed allowing the work to slide out easily.

The chutes of magazine attachments used for handling flat pieces are generally held in a vertical position, while those used for cylindrical work are held in an inclined position. The angle of inclination of the chute or slide depends entirely on the size and shape of the work. A slide for handling small work should be inclined at a greater angle than that used for large work, the angles of inclination of the chute from the cross-slide varying from 20 to 60 degrees.

* * *

NOTES ON QUENCHING FLUIDS

It is generally held, says Mr. Shipley N. Brayshaw in the *Engineering Magazine*, that the addition of sulphuric acid (oil of vitriol) to the quenching water increases its intensity, and common salt is considered to act in the same way, but in a lesser degree. Mr. Brayshaw doubts that there is any foundation to this assumption. The heat conductivity of the water may be increased by the addition of salt, but the gain from this cause is small in proportion to the powerful intensifying action which may be produced by rapid motion of the water, for instance. It appears that the great differences obtained by quenching in salt baths and clear water have been caused either by variations in the temperature of the water or by the degree to which it was agitated. It is sometimes stated that sulphuric acid is added to prevent hardening cracks, but this statement is inconsistent with the other idea that by its use a greater degree of hardness can be obtained. If the liability to crack is reduced, it is because the acid has made the quenching bath more gentle in its action, and the hardness would be reduced.

The temperature of the hardening bath has a great deal to do with the hardness obtained. In certain experiments a bar quenched at 41 degrees F. showed a scleroscopic hardness of 101. A piece from the same bar quenched at 75 degrees F. had a hardness of 96, while, when the temperature of the water was raised to 124 degrees F., the bar was decidedly soft, having a hardness of only 83. The higher the temperature of the quenching water, the more nearly does its effect approach that of oil, and if boiling water is used for quenching, it will have an effect even more gentle than that of oil; in fact, it would leave the steel nearly soft.

* * *

Mere possession of knowledge, says one of our contemporaries, has little earning capacity; only skill in the application of knowledge to the attainment of some useful purpose has earning power, because it is from such application that useful results flow.

LETTERS ON PRACTICAL SUBJECTS

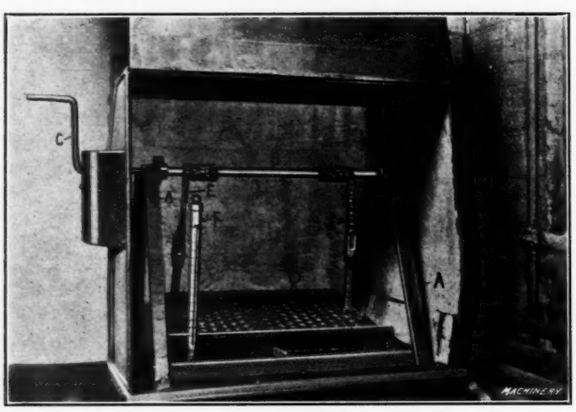
We pay only for articles published exclusively in MACHINERY.

ADVANTAGES OF THE OIL TEMPERING FURNACE

It is interesting to know that the oil tempering furnace is being adopted by leading manufacturers throughout the country because the results obtained by it are much more uniform than could be secured by the old method of drawing the temper by "color." One of the advantages of the oil tempering furnace is that the hardener can, at one heat, temper a dozen or fifty tools, and obtain uniform results. The variation in the size of the tools makes no difference. For instance, I have tempered drop-hammer dies weighing 125 pounds and at the same time reamer blades weighing less than one ounce.

The accompanying illustration shows an oil tempering furnace made by the American Gas Furnace Co., to which has been applied a device for handling the work and also agitating the oil—a point that is often overlooked by the manufacturers of oil furnaces. Two brackets *A*, one of which is fastened on each side of the furnace, hold a bar *B* provided with a crank *C*, the bar extending entirely across the furnace. The basket *D* is fastened to the bar *B* by chains *E*, so that it can be raised or lowered by means of the crank. The basket should be raised and lowered frequently during the heat to get good results. A ratchet-wheel is fastened on the bar *B*, and a pawl is attached to the bracket, so that the basket may be held in any position which is necessary when parts are only to be partially immersed in the oil.

The basket *D* consists of two plates held together by eyebolts, which are connected to the chains. The plates are separated by two ¾-inch nuts, and are provided with ⅞-inch holes, so located that the holes are not in line in the top and bottom plates. This staggering of the holes assists in mixing the oil when the baskets are quickly lowered and raised. Baskets provided with handles and made from ¼-inch mesh wire screening are also used for holding chisels, hammers,



American Gas Furnace equipped with Device for Handling the Work and Agitating the Oil

punches, etc., when tempering. These baskets can be moved quickly from the furnace and immersed in a cooling medium.

The temperature of the oil is determined by means of a mercury thermometer *F* graduated to register temperatures from 200 to 900 degrees F.

GEORGE T. COLES

Decatur, Ill.

A REVOLVING TAILSTOCK CENTER

When turning and polishing cylindrical shells, trouble was encountered with the castings becoming heated and expanding, due to running them upon a fixed center in the tailstock spindle. To overcome this, a revolving center was made, as shown in Fig. 1, with a parallel bearing. At first this gave satisfaction, but after being in use for a few months, the cone center became slack on its spindle, excessive wear taking place, as shown by the dotted lines. This was due to the pressure of the tool and the weight of the work not being evenly distributed on the conical center spindle. To obviate this, the revolving center shown in Fig. 2 was made. The spindle *A*, which fits in the tailstock spindle of the lathe, has two cones turned on it, and the loose center *B* is bored to suit. These two cones on the spindle *A* approach as nearly as possible Schiele's anti-friction pivot curve, which equalizes the pressure on the center spindle.

When the pattern for the center *B* was made, four triangular lugs were cast on it, as shown in Fig. 3. This enabled the casting to be gripped in an ordinary four-jawed chuck for boring and facing the cone-shaped hole. The small lugs were

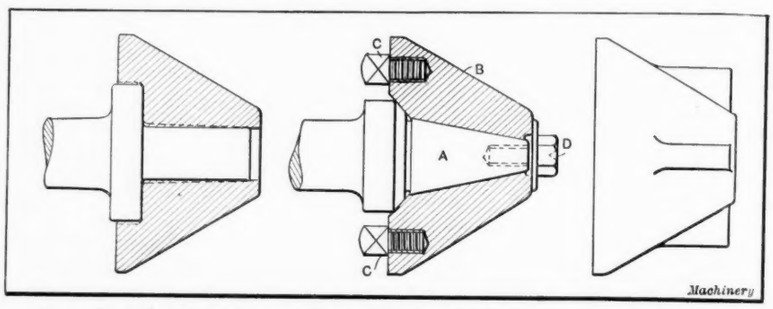


Fig. 1. Discarded Revolving Center

Fig. 2. The Successful Center

Fig. 3. Casting for the Center

then removed by drilling holes in them, and the holes were drilled and tapped for the two square-headed screws *C* at the same time.

To turn and grind the center *B* on its conical face, it was mounted upon the spindle *A* and held with the cap-screw *D*. Then the spindle *A* was placed in the headstock of the lathe, and the tailstock center placed in the center in the head of the cap-screw *D*, to steady it. The two set-screws *C* act as drivers, coming in contact with two projections on the face-plate.

P. H.

MAKING SURFACE PLATES BY LAPPING WITH CARBORUNDUM GRAINS

Any toolmaker who has had experience in different shops will admit that he has met with difficulties more than once in trying to find a suitable surface plate for laying out work or for scraping a piece to a bearing. Surface plates are regarded in many of the smaller shops as expensive luxuries, although it is recognized that they are a valuable asset in the production of accurate work. To make a surface plate when there is no master plate to scrape to is an expensive operation, as three plates must be made in every case. While two surfaces can be scraped to a bearing so accurately that one will lift the other by cohesion, either one of them if tested on a master plate might appear convex or concave. In the case of three plates, No. 1 and No. 2 are first scraped together, then No. 2 and No. 3, and then No. 3 and No. 1 and so on, until perfect planes are obtained.

To scrape a sixty per cent bearing on three plates, obtaining true planes, is a long and expensive operation, and it is no wonder that the average shop foreman is not very enthusiastic about attempting it, as he knows very well that not one machinist in a hundred has had the necessary experience at this class of scraping to turn out a good job in a reasonable length of time. Accurate surface plates can, however, be made in a surprisingly short time if the following method is employed:

First rough off the surface and the feet, taking off at least three-eighths inch to make sure that all the surface iron is removed. This will prevent warping. Then drill and tap the holes for the handles. The plates should then be allowed to

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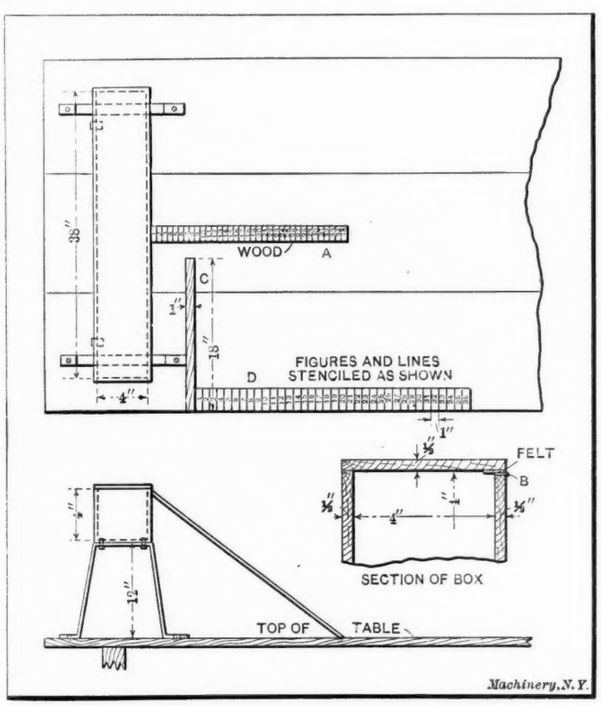
season for at least two months to allow the internal strains to permanently adjust themselves. To finish the plates, all that is necessary is a small amount of carborundum grains for lapping the plates together. Before starting to lap, stamp the plates No. 1, No. 2, and No. 3, respectively. Lay No. 2 on the bench, sprinkle some No. 36 carborundum grain over it, add a little coal oil, and lap No. 1 with it, using a circular motion, and constantly changing the relative position of the upper plate until something like a finished surface is obtained. Then lap No. 2 and No. 3 in the same manner, then No. 3 and No. 1, and then do the whole operation over again. By this time reasonably plane surfaces should have been obtained. Then repeat the procedure, using No. 60 carborundum grain. Then use No. 120, and follow this with No. 220 for the final finishing. The result will be three surface plates with perfectly true planes, a good finish, and a 100 per cent bearing. If the lapping has been carefully done, these plates will lift each other by cohesion.

Many will argue that this method of lapping plates together will so charge them with the abrasive material as to make them unfit to use with fine tools. However, when it is considered that cast-iron holes in accurate watch machinery are lapped to a bearing, and put to every-day use without wearing out the spindles or shafts that run in them any sooner than those used under the same conditions but not lapped, it is doubtful if surface plates can be loaded with abrasive material to such an extent as to make them unfit for use with fine tools. The writer has himself used this process for making plates 12 inches square, having a surface ½ inch deep, and with a base of the regular ribbed construction.

Niagara Falls, N. Y. F. B. JACOBS

BOX FOR HOLDING BLUEPRINT PAPER

In cutting and tearing up blueprint paper for making blueprints, a considerable amount of the paper is wasted; for instance, when a print is to be made from a tracing 24 by 36 inches, the paper is generally cut or torn with from one to four inches of unnecessary border, which will be waste paper when the print dries. With the device shown in the accompanying engraving, as much as four and five yards of paper



Box for Holding and Device for Saving Blueprint Paper

can be saved on a 50-yard roll. When the necessity of measuring the paper every time a print is to be made, is thus dispensed with, the work can be done more expeditiously.

The box can be made of ½-inch pine or poplar boards at small cost. It is secured on the end of a table, as shown, with two ¼- by 1-inch iron legs screwed to the top of the table, the box being bolted to these legs by ¼-inch carriage bolts. It will hold a 50-yard roll of paper, and no light can penetrate into it. The iron strip shown at *B* is set into the front of the box and firmly secured with countersunk wood screws. The purpose of this strip is to provide a means of tearing the paper off along the edge. A piece of felt is fastened on the front lower edge of the lid to keep a uniform pressure on the paper when tearing it off; but, of course, if the lid is held down, the paper will tear off better.

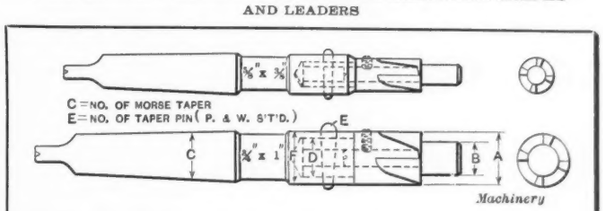
Mark on a piece of cardboard all the different sizes of tracings and hang it up where it can readily be seen. Opposite these figures allow a ¼-inch margin; for example, for a tracing 6 by 9 inches, tear to 6½ by 9½ inches. The wood strip at *A* is nailed to the table and box as shown. When making prints, take hold of one end of the paper and pull it out of the box to the desired width, and then tear off by pulling downward. Having obtained the correct width, lay the paper flat on the table, one end against the wood strip at *C* and along the scale at *D* which is divided off into inches, and with a straightedge tear the paper off to the desired length. For larger blueprints, larger scales can, of course, be made.

Toledo, Ohio. W. H. WOLFGANG

COUNTERBORES WITH REMOVABLE SHANKS AND LEADERS

As high-speed steel costs about four times as much as good carbon tool steel and about thirty-five times as much as machinery steel, the tool designer who wishes to economize is always careful to design tools so as to use as little high-speed steel as possible. The engraving accompanying the table shown herewith illustrates a plan by which a consider-

PROPORTIONS FOR COUNTERBORES WITH REMOVABLE SHANKS AND LEADERS



A	½"	9/16"	⅝"	¾"	¾"	1"
B	5/16" to ⅜"	5/16" to 7/16"	5/16" to ½"	5/16" to ⅝"	5/16" to ¾"	5/16" to ¾"
C	No. 2	No. 2	No. 2	No. 3	No. 3	No. 3
D	½"	½"	½"	⅝"	⅝"	¾"
E	No. 0	No. 0	No. 1	No. 1	No. 2	No. 2
F	¾"	¾"	¾"	⅞"	⅞"	1"

able saving may be effected in the design of counterbores. The cutting portion of the counterbore is made from high-speed steel, the leader from ordinary carbon steel, and the shank from machinery steel. The design of counterbore not only effects a saving in the use of high-speed steel in the original manufacture of the tool, but also facilitates the replacement of broken or worn-out cutters, the same shank being used continuously. It also has an added advantage over the solid type owing to the fact that it is furnished with an inserted leader, which may be replaced when broken or when other sizes are required.

These counterbores can be made with two, three, four, five or six cutting edges, depending upon the class of work on which they are to be used. For clean brass castings, and where the hole extends part way into a shoulder, five or six cutting edges are preferable. For rough steel castings two, or not more than three, cutting edges are better, because the heavy strain on the cutter is liable to break the cutting edges, unless they have a good support. Straight shanks may be used if necessary. The reason that the counterbore shown in the illustration is supplied with a taper shank is that a large majority of manufacturers are now using tapered instead of straight shanks on all drill press tools above 5/16 inch in diameter.

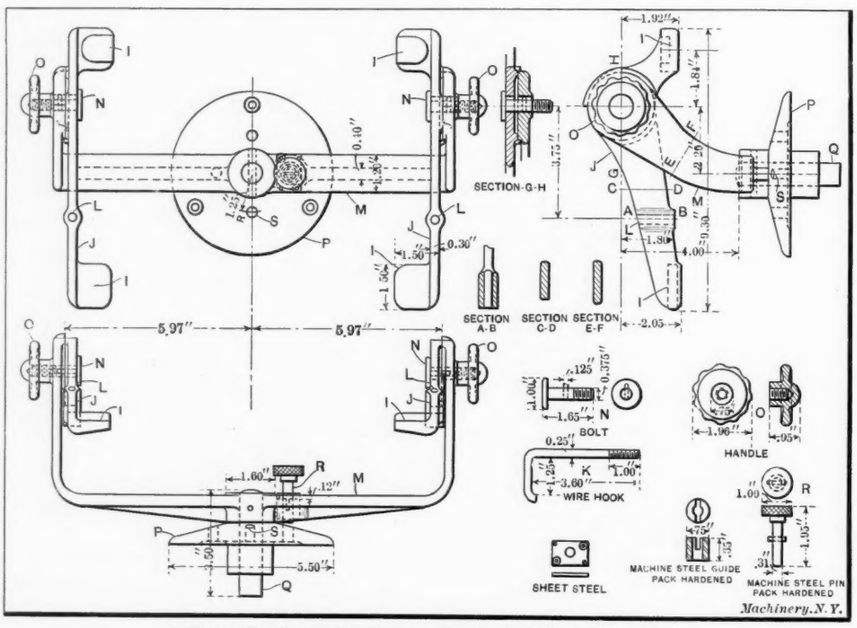
Referring to the illustration, the dimension *D* and the taper pin *E* are fitted before the cutter is hardened. A 5/16-inch reamed hole is also provided in the cutter to fit the

shank of the leader. Drilling the hole entirely through the cutter facilitates the removal of the leader when necessary. Sufficient material is left on the cutter to grind to the size required, after it has been assembled. The leader hole is slightly chamfered so that a small fillet may be left on the shank of the leader to overcome the tendency to crack when hardening. The leader is also ground on its own centers, and the shank is made a snug fit in the 5/16-inch reamed hole. The body of the leader is ground from 0.002 to 0.005 inch smaller than the hole in which it is to work. Care should be taken not to allow either the taper pin or screw for holding the leader to protrude far enough to catch the workman's clothing. Larger counterbores can also be made along the same general lines, if so desired.

Indianapolis, Ind. G. W. LINN

A TYPEWRITER INSPECTION FIXTURE

The accompanying illustration shows an ingenious fixture designed for holding a typewriter of the general form, such as the Remington, Underwood, L. C. Smith, etc. This fixture has aptly been termed a "turntable," for it is so built that a machine, after being placed in position on it, may be turned to either side, entirely around, to any angle vertically, or upside down. In the final inspection, it is necessary to look over every part of the mechanism, and by the use of this turntable any part of the machine may be easily reached without the inspector's having to leave his seat or lift the machine.

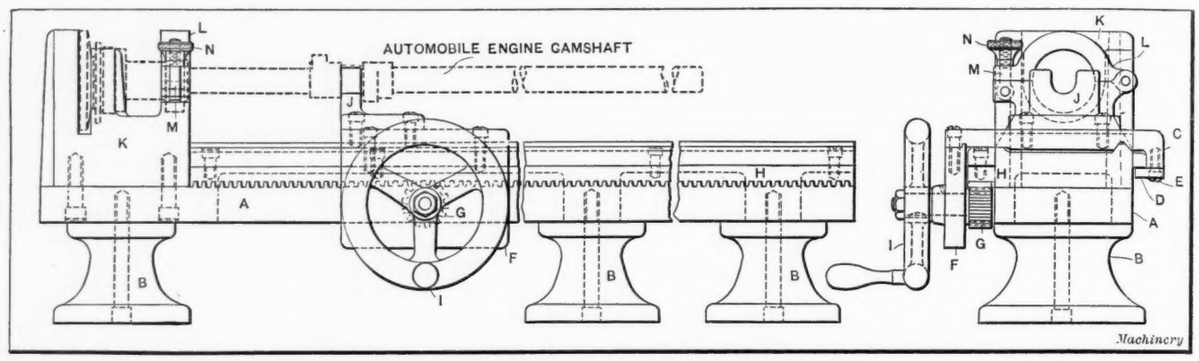


A Typewriter Inspecting Fixture, showing Details of Construction

The four feet of the machine are placed in the recesses *I* on the cradles *J*. A wire hook *K* on each side extends through the hole *L* and grips the frame of the machine, the hooks being tightened by a nut and check-nut. The cradle castings are secured to the frame casting *M* of the fixture by bolts *N* and are fastened at the desired angle by tightening handles *O*. *P* is the base casting which is screwed to the bench. The frame *M* turns about this base on the pin *Q*, which is fastened to the frame. The latter is secured in position by dropping the pin *R* into one of the holes *S* in the base. DESIGNER

FIXTURE FOR PRESSING CAMS ONTO AUTOMOBILE ENGINE CAM-SHAFTS

The fixture shown in the accompanying illustration was recently designed and made in our factory for pressing on and removing cams from automobile engine cam-shafts. A good deal of trouble had been experienced in assembling the cams on the shaft by means of a babbitt hammer and a piece of pipe, as it caused considerable breakage of cams and springing and scoring of the shaft, which made the latter unsatisfactory as a bearing when a cam was finally placed in position. The cams are hardened and ground in the hole, have a 3/16- by 3/32-inch keyway, and are assembled before grinding on the outside. The hole in the cam is made a press fit for the shaft, and it is necessary to have the pressure as evenly distributed as possible on the cam when forcing it on, to avoid scoring the shaft. This fixture was designed to meet future, as well as present requirements.



A Fixture for Pressing Cams onto an Automobile Engine Cam-shaft

Referring to the illustration, the bed *A* is made much heavier and is considerably longer than was necessary for the present shaft. It is supported on three legs *B*, fastened to the bench. The carriage *C* has a V-shaped bearing on one side and a plain bearing on the other, which affords ample wearing surface, insuring long life to the fixture. Gib plate *D*, held with screws *E*, prevents the carriage from being lifted from its bearings. The apron *F* carries a pinion *G* meshing with the rack *H*.

The U-shaped block *J*, in which the cam-shaft is located, is fastened rigidly to the carriage by fillister screws, and is cut out to fit loosely over the shaft. It is made of a sufficient width at the top to go between two cams, as shown, which, of course, is necessary if the cams are to be removed from the shaft. About two-thirds of the cam surface bears against the block *J*, equalizing the strain and preventing the cam from scoring the shafts.

The large end of the cam-shaft is located in the main bearing *K* and is held in position by means of a clamp *L*, swinging-bolt *M* and thumb-nut *N*. The head of the fixture is so constructed that it prevents the shaft from moving in either direction so that cams can either be put on or removed. With the exception of pinion *G* and block *J*, all the various parts of this fixture are made of cast iron.

Lansing, Mich. E. H. PRATT

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A DRILLING PROBLEM

In the following article is described a simple and economical method of machining what would be, under ordinary conditions, a very awkward piece of work. The bosses shown in Fig. 1 were to be drilled, tapped and faced, making the holes exactly in line. Owing to the length of run it was impracticable to braze a round shank drill to the end of a rod; three drills at least would be required, even if our largest horizontal drill was used. These drills would be tied up, and

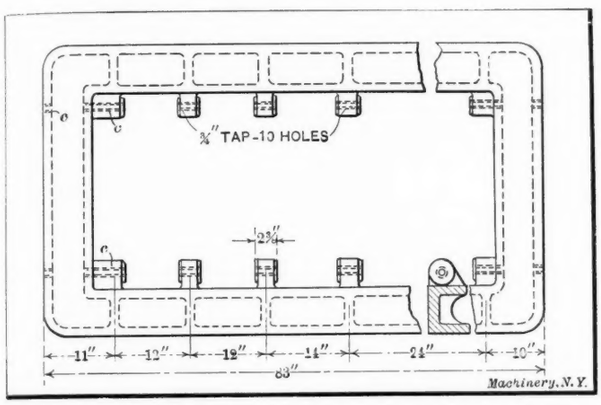


Fig. 1. The Drilling Problem—How to Drill, Tap and Face the Bosses

in addition to this, the finishing of the bosses would still have to be considered.

The job was finally done on an old-time Pond horizontal drill. Two bars were secured across the narrow way of the piece, and the whole was then bolted, by means of these two bars, to an angle-plate, previously set in position on the drill base. After leveling the job up, the holes were scribed off by means of a surface gage and a chalk line. The casting was then turned over and the lugs on the other side were marked off in a similar manner.

Fig. 2 shows the method of driving the drill, a similar method being applied to the counterbore and tap. A plain coupling was drilled and reamed to the size of the drill which it

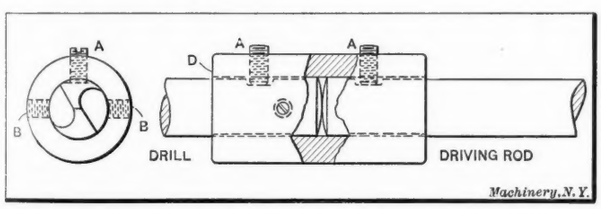


Fig. 2. Special Coupling used in Drilling, Facing and Tapping the Bosses

was to hold. Set-screw holes *A* and *B* were drilled and tapped, the set-screws *A* seating in flats, filed in the drill shank and driving rod, respectively. Three rods of cold-rolled steel were then turned true for a distance of about two inches from each end, to act as drive rods. The first rod was approximately 20 inches long, the second, 44 inches, and the third, 78 inches; all of ⅝-inch stock. At the outset trouble was anticipated from the use of these rods, owing to the twisting strain, but contrary to expectations, no difficulty was experienced and the drill was fed through by hand at a very good feed.

The holes *c* in the end of the casting are merely drilled to allow the passage of the drill, and were made with our best "extra-length" drill, which had a twist cut of about 9 inches. This drill also started the tap hole through the first long boss and prevented the round-shank drill, in the special rig, from running out. When the "extra-length" drill was used as far as possible, it was removed and a chuck put in the spindle. Then the driving rod was chucked and passed through the work, the coupling in which the drill was set was put on the end of the rod, and the hole drilled. In using the longer rods, they must be passed through the drilled holes to be chucked, to give sufficient room. The different length rods were employed to reach the different bosses all the way through. The facing of the bosses was done in a similar manner.

For tapping, the same coupling was used, but the tap was held loosely on the shank square by the set-screws *B*, which allowed it some slight play, practically forming a floating tap. When the ends of the coupling *D* came down against the boss, the tap would pull out of the coupling, eliminating the danger of a broken tap. The different length rods were used as in the drilling operation.

In changing rods, either the table or housings of the horizontal machine had to be moved. After doing this, the spindle could be again lined up by running the chuck down over the rod; when the housings were thus properly adjusted, after each new rod had been introduced, the operation was proceeded with.

This idea may be used on any drilling machine and will be found very useful; for, unlike many kinks, it is practicable.

CHIPS

A NOVEL DRILLING JIG

The drilling jig shown in Fig. 2 was designed to drill holes in collars, jam-nuts and cotter-pin holes in spring rods, as shown at *A*, *B*, and *C* in Fig. 1 where six holes ⅜ inch in diameter, and eight holes ¼ inch in diameter are drilled. This jig can be furnished with bushings so that pieces varying from ⅜ inch to 2 inches in diameter and holes up to ¾ inch

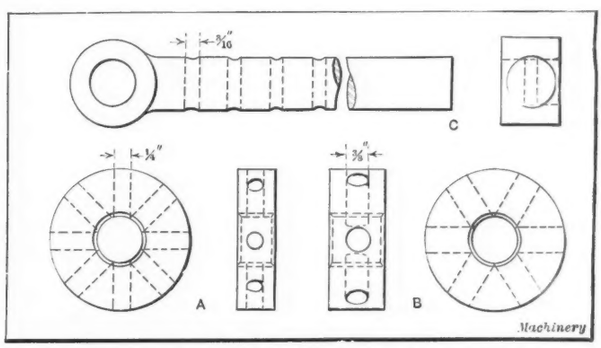


Fig. 1. Examples of Work drilled in Jig shown in Fig. 2

can be drilled. Referring to Fig. 2, the jig proper is simply a V-block *A* made of cast iron, which is slotted out to receive the adjustable V-support *B* held with a cap-screw as shown. This V-support *B* is made adjustable so that it can support the work when drilling a number of holes around its circumference. The work is lined up by the plug *C*, which is inserted in the holes *D*, *E* and *F*, respectively. Where four holes are to be drilled, the plug *C* is inserted in

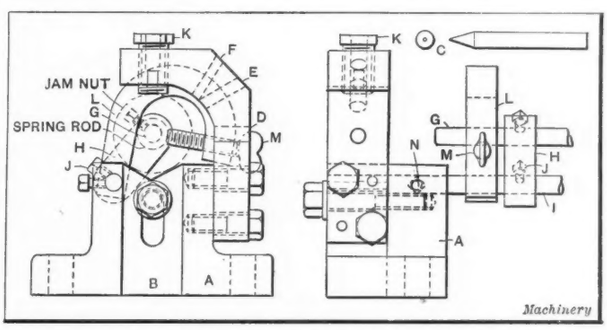


Fig. 2. A Novel Drilling Jig for Drilling Holes in Jam-nuts, etc.

the hole *D*, for six holes the plug is inserted in the hole *E*, and for eight holes the plug is inserted in the hole *F*.

Where it is necessary to drill a number of holes around the circumference from the end of a piece of work, the stop *G* is used. This is held in a block *H*, which is free to slide on the rod *I*, and is clamped in the desired position by the set-screw *J*. The work is held down at all times on the V-support *B* by the drill bushing *K*, which is threaded into the fixture.

When a number of cotter-pin holes are to be drilled in a spring rod, as shown at *C* in Fig. 1, the bracket *L* is used

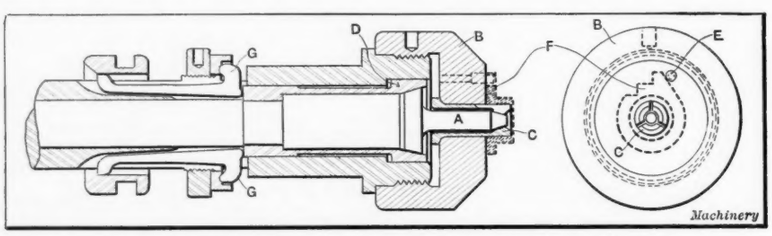
to hold the rod, so that the holes are drilled in line with each other. This bracket *L* is free to slide on the rod *I*, and the spring rod is held against the inner surface of the bracket by means of the thumb-nut *M*, as shown in the illustration. The stop *G* is then used for locating the center distances for the holes in the piece *C*, Fig. 1, and can either be adjusted by loosening the set-screw *J* or the set-screw *N*, preferably the latter. The distance from the face of the V-support *B* to the center of the bushing *K* is ¾ inch, and the measurements can always be taken from the face of the V-support. As exceptional accuracy is not required in this class of work, this jig will be found very satisfactory.

Plainfield, N. J. DAVID MCINNES

SPECIAL EXPANSION COLLET FOR A HAND SCREW MACHINE

In the accompanying illustration is shown a section and end view of the spindle of a Brown & Sharpe hand screw machine, the special expansion collet, and the mechanism used in operating it. It will be noticed that in place of the regular collet there has been substituted a solid plug *A*, which reverses the closing action of the collet, or, in other words, provides an arbor for holding the work *F*, on which a turning operation is to be performed. The operations previously performed on the piece *F*, shown in heavy dotted lines, were boring, reaming and facing one end.

The cast-iron cap *B* contains a bushing *C*, which has been bored taper from the rear and split to allow for expanding. The expanding of this bushing is accomplished by means of the tapered plug *A*, which is provided with two beveled ends, as shown, one of which fits into the bushing and the other into the tapered hole in the regular sleeve *D* used in holding the ordinary spring collet. The plug *A* is moved forward by means of the fingers *G*, which, of course, are provided with the regular spindle on the screw machine. The pin *E*, driven into the cap, acts as a drive for the work *F*, so that



A Special Expansion Collet for a Brown & Sharpe Hand Screw Machine

sleeve *C* is adjusted to hold the work only moderately tight.

Tottenville, S. I. S. J. PUTNAM

STAMPING FIXTURES FOR PLUG AND SNAP GAGES

The production of neat, correctly spaced and well-arranged figures and letters on small tools, gages, etc., when made in

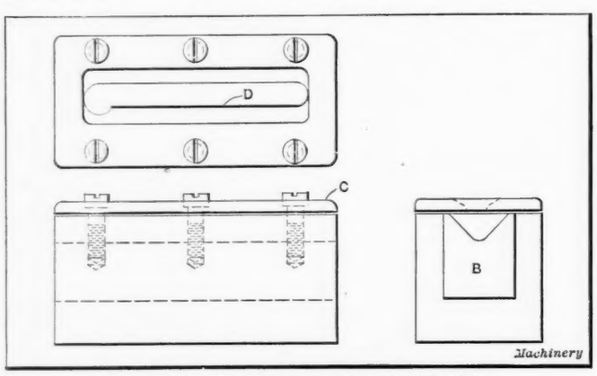


Fig. 1. Stamping Fixture for Plug Gage Handles

the average tool-room, is frequently a problem which is not given the attention it deserves. The accompanying illustrations, Figs. 1 and 2, show two fixtures designed to perform this work in a workmanlike manner and at a minimum of time and expense. Fig. 1 shows a fixture used in stamping the handles of plug gages, round-end measuring rods, reamers, etc. *B* is a bronze block provided with a slot in which the work rests when being stamped, while the cap *C* is screwed down on the work, holding it in position. The stamps are lined up against the edge *D* of cap *C*, so as to make each line of characters parallel.

Fig. 2 shows a fixture designed for stamping flat work, such as snap gages, etc., the operation of which will be

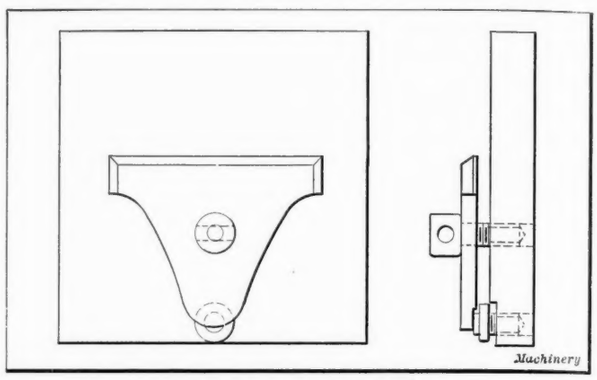


Fig. 2. Stamping Fixture for Snap Gages

readily understood from the illustration. Both of these fixtures have been successfully used in the model and gage department of a leading manufacturer of small arms in this country, and have proved all that could be desired where only a few pieces of a kind are to be stamped at one time.

Hartford, Conn. F. CHARLES SCRIBNER

AN APPEAL (?) FROM A MECHANIC IN TROUBLE

I am having a great deal of trouble in my work and write to you, thinking you may be willing to help me out. I am using a book containing over 2000 illustrations, published in 1907, "regardless of trouble or expense." First, it was necessary to do some fine drilling; the following instructions were found in the book:

"USING LATHE FOR FINE DRILLING"

"A worn lathe can be made to do fine drilling, no matter how badly it may be out of truth, or how loose the spindle may be in its bearings. So long as there is a turning motion at one end of the lathe bed, and the capability of pressing the work forward at the other end with either a handwheel or lever, all kinds of drilling, thick and thin, heavy and light, can be done, but there must be a handy chuck for holding drills and a variety of tools for drilling. If one of them is placed in the chuck and the jaws shut down solid upon it, and the lathe set in motion, it will be noticed that the drill does not run true, but a *few blows with the hammer* will soon fix this, so that at least the point will remain in one position except when the belt fastening passes the driving pulley when it vibrates for a moment. The body of the drill has a *peculiar motion*, and it is here an *old lathe* has the advantage—the drill is ready to enter wherever it finds a cavity to settle in, and the *looseness* of the spindle allows for an *adjustment* on a new center; besides, the drill is ground a little uneven, and is cutting a hole larger than the body of the drill, which is all the better as this part is so badly out of truth. As the depth increases, a *wobbling* motion comes in at the sides of the drill, striking against the walls of the hole; *this does not matter*, the drill can reach the full depth without breaking off in its socket or slipping in the jaws of the chuck. Whenever the edge is torn away, the wrench may be hooked onto the feed lever, while with *the pipe-wrench* the chuck can be set up so solid that there is no need to use the *three flat places* (if they exist, and they are not recommended) ground on the shank of the drill."

As I am using a lathe nearly new and do not know how to fix it, do you think it would be better to sell it, and buy one like that described above?

Next it was required to harden some steel, and the following rules were discovered:

"For a drill, tap, or reamer, the tool steel should be heated to a dull red only.

"For a center punch, a bright cherry red.

"A lathe cutter should be something between the two; so it must be heated to a full red.

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"For hardening liquids, tallow, rosin, brine, and *molten lead* are recommended."

I worked all day with the molten lead without getting any hardness, and it was difficult to get the pieces out of the lead when it became cold. Please help me. AMATEUR

[Mechanics can appreciate the humor of this ridiculous rot, but what is the effect of such misinformation on the class for which it was written? The book from which the foregoing quotations were taken was published several years ago and has had considerable sale. It is impossible to estimate the damage done by such misinforming literature to its readers and to really meritorious publications written by practical men. Much of existing prejudice to book information could doubtless be traced to trash written by incompetent amateurs and purchased by apprentices and mechanics in the hope of being better informed about their trades.—EDITOR.]

BALL AND ROLLER BEARINGS IN MACHINE TOOLS

On page 344 of the January, 1912, number, engineering edition, I read with much interest an editorial "Ball and Roller Bearings in Machine Tools."

In this editorial you say: "It is not perhaps to be expected that ball or roller bearings will be generally applied to such parts as lathe spindles. While they have given excellent results in severe service, the jar and vibrations of heavy intermittent cuts would prejudice most mechanical engineers against their use. But even if the main bearings of working spindles are hardly feasible places to apply them, there are many other plain bearings in lathes, milling machines, drilling machines, and other machine tools, that could be displaced by anti-friction bearings with large resulant saving of power."

This editorial conception is based on error. It is a fact that ball bearings are being used on the main spindles of lathes and lathes, moreover, of the type called upon to do the heaviest kind of work, such as high-speed production lathes and similar tools. Used on such spindles the employment of the ball bearings has resulted in an increased output with a decreased power loss. Not only that, but the question of wear of the bearings has been incidentally entirely eliminated. In fact it has been possible to so arrange the spindles that the attendant could not, even if he were so inclined, adjust the bearing. With the ball bearing, the journal as it left the maker's hands is constant throughout the life of a machine. No attendant with a monkey-wrench can in any way change the bearing or affect it adversely.

A little in the way of records taken first from a European lathe—that is to say a roughing lathe built by Ludw. Loewe & Co. of Berlin might be of interest:

Feed Per Revolution	Circumferential Speed in Feet Per Minute	Depth when taken by Two Tools Simultaneously
0.0394 inch	111.5 feet	0.5 inch
0.0394 inch	65.6 feet	1.18 inch
0.0394 inch	152.5 feet	0.55 inch

Chips Removed in Pounds Per Hour	Consumption in H.P.	Consumption in H.P. Per Pound of Chips Per Hour
396 lb.	14.1 H.P.	14.1/396 = 0.0356
480 lb.	16.6 H.P.	16.6/480 = 0.0346
515 lb.	17.1 H.P.	17.1/515 = 0.0332

We believe that this table will convince you that the ball-bearing lathe main spindle makes an exceedingly efficient combination. Please note that this record was made on steel having a tensile strength of 80,000 pounds per square inch and at that with 9/16 inch depth of cut and a speed of over 150 feet per minute. The power requirement is only 3/100 H.P. per pound of chips per hour.

The other point that you raise concerning the jar and vibrations can best be answered by quoting an experience with a Lodge & Shipley lathe in our own works here in Philadelphia, which lathe some seven years ago was equipped with ball bearings on the main spindle. After five years of use, during which time absolutely no adjustment of any kind was given the bearings and during which time the lathe was used not only all day, but also for night work and on roughing work and a general range of work of very severe character, it was found that a test roughing cut taken on a bar of 5 inches diameter and 22 inches length showed maxima of variations from absolute roundness of only 0.0030 inch. Taking a finishing cut over this bar then showed maximum variations of roundness of only 0.0008 inch.

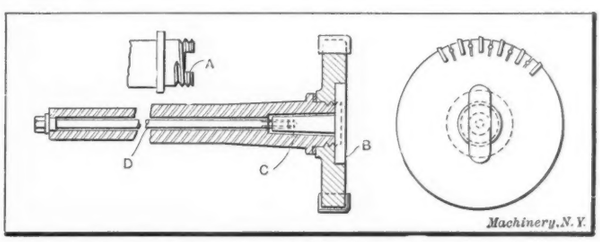
We doubt very much whether a plain spindle lathe fresh from the maker's hands would give as good results as to accuracy as this ball-bearing mounted lathe gives after five years strenuous service. HENRY HESS

Philadelphia, Pa. Hess-Bright Mfg. Co.

[The use of ball and roller bearings on machine tool spindles subjected to heavy side pressures is so limited that the cases cited are interesting, but hardly conclusive. The average lathe buyer will be likely to proceed cautiously when investing in equipment, as regards anti-friction bearings on the spindles, until he is absolutely convinced by many examples that they are reliable.—EDITOR.]

DEVICE FOR FASTENING THREADED MILLING CUTTERS TO SPINDLE

Possibly every milling machine operator has experienced some trouble when trying to remove face mills which are screwed onto the spindle nose, as it is a common occurrence for such mills to become wedged tight against the spindle collar. To overcome this tendency to "stick," the writer made a simple device for fastening the cutter as shown in the engraving. In order to use this attachment the milling machine must have a slot across the face of the spindle as shown at *A*. A recess is milled in the body of the cutter of exactly the same width as the slot in the spindle. Into this recess is fitted a plate *B* having a projection *C* on the inner side which



Device for Fastening Threaded Milling Cutters to Spindle

is provided with a tapped hole for the draw-bolt *D*. The only reason for having this projection is to enable the draw-bolt which is furnished with the machine to be used.

In order to use the same cutter on different spindles, a hardened and ground washer should be put between the mill and the spindle collar. This washer may vary in width for the different spindles, and should be of such a width that the hub of the cutter will just touch it when the recess in the mill and the slot in the spindle are in line. It does not matter if the thread of the mill should happen to fit a little loosely on the spindle, as, by tightening the draw-bolt, the cutter will be clamped against the washer and spindle collar. It is of importance, however, that the counterbore in the mill should be a good fit on the blank part of the spindle nose, and that the plate *B* fit snugly into the recess and slot. If this last condition is observed, there will be no trouble from the mill's sticking, as the plate *B* will resist any wedging tendency.

H. I. N.

COMMENT ON CHAIN CASES

In the editorial in the November number of MACHINERY, on unprotected power transmission chains, attention is called to the seemingly bad practice of using uncovered sprocket chains, and it is said that the practice is indefensible and should be abolished. The use of uncovered chains on heavy motor trucks in this country is, however, defensible, owing to the varied road conditions under which these trucks operate. Even the smooth, asphalted city streets are very frequently not taken care of, and have holes deep enough to allow the rear wheel to drop into them, resulting in the breaking of the cases; and the unpaved country roads are full of ruts into which a truck will sink to its hubs. Apparently these are the very conditions against which the chains need

to be protected, but they are the ones that break the cases and hold up the truck for repairs, which is a greater detriment to the efficiency of the truck, in the eyes of a business man, than the decreased efficiency of the power transmission chains. Such repairs and the loss of time entailed are costly, and in a year's time more than offset the cost of new chains. The ability of a truck to be run daily for a specified time before going to the repair shop gives the business man faith in the motor truck.

On touring car design, where the chain-drive has almost entirely disappeared and where the conditions under which the drives operate are not as severe as in the case of the motor truck, chains would have survived longer with cases, as the noise made by the uncovered chains was the great objectionable feature to their use. When one considers the time that has been spent by designers to produce quiet-running motors and transmission gears, it seems strange that more time has not been spent upon this problem. Chains are manufactured by makers of accessories, and as the makers of chains have never insisted that chain cases should be used, the reason for a seemingly bad practice is apparent.

Brooklyn, N. Y. JOHN F. WINCHESTER

MAKING MILLING MACHINE SPINDLES

The article on the making of milling machine spindles by Mr. John Goetz in the October number of MACHINERY is not only interesting but instructive; particularly so is the method described for broaching the tang slots at the bottom of the taper hole, which shows a satisfactory way of doing a difficult piece of work, and incidentally illustrates the usefulness of the slot cutting attachment. But after going to the trouble of broaching these tang slots, why are they not made use of by providing the arbor with a tang?

We have recently installed a Kempsmith Lincoln type milling machine of the latest design, and after reading the article referred to, we took out the arbor to see if the spindle was broached as described. The slots had been cut, but the curious point is that there is no corresponding tang on the arbor; in fact, the end of the arbor does not reach within half an inch of the slots.

Furthermore, the draw-bolt for securing the arbor in position is screwed in with a right-hand thread, which, in the absence of a positive drive, allows the arbor to work loose under the reaction of the cut unless screwed up unduly tight, in which case the nut at the rear of the draw-bolt is absolutely useless for forcing the arbor loose when it is to be removed.

A. E. DODWELL

Works Manager for Clay & Atkinson, Bradford, England

THE REPLY

In reply to the question asked by Mr. A. E. Dodwell, Works Manager for Clay & Atkinson, Bradford, England, the writer would like to offer the following explanation: By referring to the article mentioned, it will be seen that we have no trouble in doing the job which Mr. Dodwell in his letter says is a difficult piece of work. It is, therefore, a small outlay for us to continue putting tang-slots in spindles with small tapers to accommodate those of our customers who might have equipment of the older type (as builders of milling machines until recently supplied all millers with slots to receive tang arbors). A good many have discontinued using tang arbors entirely, and others partially, for reasons sufficient to warrant the change.

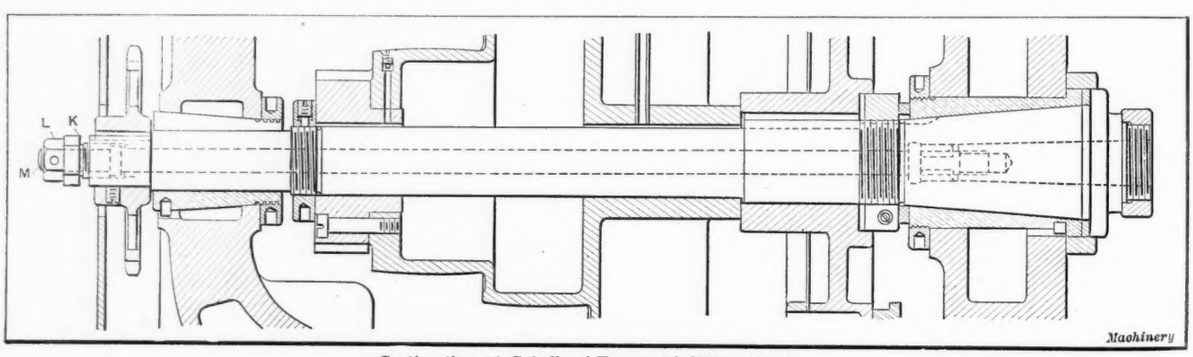
We are among those builders who by discontinuing the tang arbor thought they were doing so to the interest of the user. In the early days, when the milling machine was in its infancy, the tang on an arbor was sufficient to drive the arbor. Now, since the advent of high-speed steel with increased feeds and speed, using tools to the limit of their capacity all the time, a tang at the rear end of the arbor is not sufficient to drive the arbor; the same thing happens to the tang arbor that occurs with a taper shank drill—the tang twists off. We are all as mechanics trying to get away from that; once away from it we will never go back.

There is no provision made to hold the tang arbor in place, or to hold it snugly in its seat while under working strain. When it becomes loosened slightly, the tang alone must continue to drive the arbor, and either the tang will break or the work will be spoiled by the arbor coming out of the spindle until the arbor nut comes against the pendent, which prevents it from falling out before the trouble is noticed.

We continue putting slots in spindles to accommodate such of our customers as may have tang arbors, collets with tangs, or small end mills with tangs; or, if a customer prefers a tang arbor, we will furnish him one for the asking in exchange for one sent with the machine. These are the reasons why we continue putting slots in the spindles and also why we have discontinued using tangs on arbors unless specified. We think it the best way to hold a taper of the smaller size such as the No. 10 and No. 11 B. & S. tapers positively seated under all conditions of work.

The operation of the arrangement, as indicated in the illustration, is as follows: To draw in the arbor, screw the rod *M* by hand, by means of nut *L*, into the arbor, until the pilot on the rod bottoms in the threaded hole in the end of the arbor; then give nut *L* a short additional turn with a wrench; then screw sleeve *K* backward to the left till it is tight. This firmly seats the arbor. To push out the arbor, give sleeve *K* a quick turn to the right. This should unseat the arbor with a snap. If not, tapping with a small hammer will release the arbor, and then it can be unscrewed by nut *L*.

The object of having the pilot on the rod bottom in the threaded hole in the end of the arbor is to make a unit of the rod and arbor—as near, at least, as it is possible to make it so under the circumstances; then by drawing in the arbor with a wrench on *K*, which has 16 threads per inch, one can easily draw in the arbor tight enough to prevent it from turning; the arbor can also be forced out with ease. We do not depend upon the rod to prevent the arbor from turning, but it does hold the arbor seated so snugly that it practically makes one piece of the spindle and arbor, regardless of the direction in which the machine is revolving; and yet it allows of interchanging arbors whenever it becomes necessary.



Section through Spindle of Kempsmith Milling Machine

The writer is of the opinion that discussions of this kind are a great benefit to the builders, as well as to the public; in this way we all get an insight into many things which at first seem unimportant.

Milwaukee, Wis. JOHN GOETZ

* * *

A man who has to do his work without proper appliances sure earns his wage, but whether or no he makes a profit for his employer is another question.—*Exchange.*

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SHOP KINKS

PRACTICAL IDEAS FOR THE SHOP AND DRAFTING-ROOM

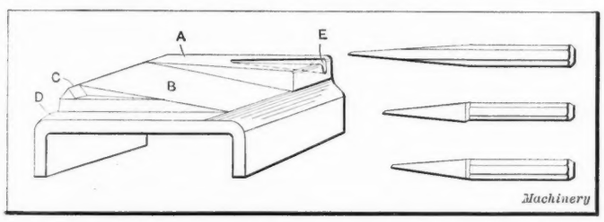
Contributions of kinks, devices and methods of doing work are solicited for this department. Write on one side of the paper only and draw sketches on separate sheets.

THE PREPARATION OF TRACING CLOTH

Much has been written on the subject of preparing tracing cloth, and each writer has his own method, which naturally appears to him to be the best. Our work requires drawing on the cloth first with a pencil, so if powder is used in the preparation it is almost impossible to draw light fine lines, as the powder makes them broad and increases the difficulty of rubbing them out. If the cloth is prepared after penciling, the rubbing in of the powder erases the pencil lines. Another objection to the powder is that it clogs up the pen. After much experimenting we have concluded that the blotting paper method is the most efficient. A soft piece of blotting paper will clean the drawing of all grease, make it take ink perfectly, and does not obliterate the pencil lines. Of course the dull side of the cloth must be used for the pencil work, and the smooth side for tracing. Alcohol is applied with a piece of cotton. This shrinks the cloth, cuts it sufficiently to take the ink, and does not destroy the gloss. J. M. H.

AN ANVIL BLOCK FOR THE STEAM HAMMER

The accompanying illustration shows an anvil block which can be used under a steam hammer for making chisels of the chipping, round-nosed or cape variety. The block is made from tool steel. The part *B* is used for tapering the chisel; the part *D* for narrowing after the chisel has been tapered;

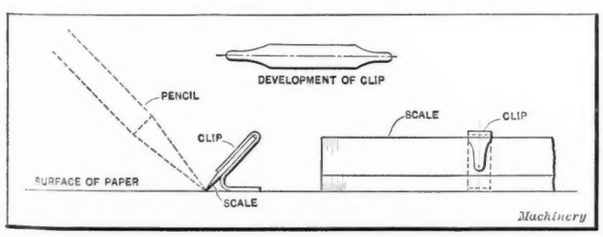


the parts *A* and *E* are used for cape and round-nosed chisels; and the part *C* is used for cutting off. By the use of this anvil-block one blacksmith can easily make from 75 to 110 chisels per hour.

Nashville, Tenn. T. O. MARTIN

CLIP FOR A DRAFTSMAN'S SCALE

The clip shown in the accompanying illustration is used for holding a draftsman's flat beveled-edge steel scale at a convenient angle for transferring dimensions direct to the drawing. By the use of a scale held in this manner, dimensions can be laid out more quickly than by using the dividers.



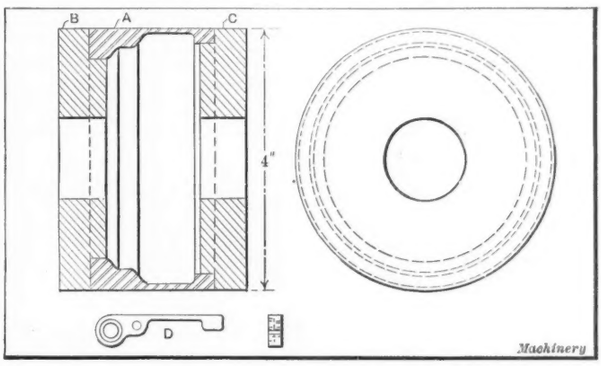
It also obviates the task of lifting the flat scale from the paper. The clip is made from flat spring steel, bent into the shape shown, and spring tempered. When the scale is required for measuring purposes, the clip can easily be removed. J. L.

RECEIPT FOR LEAKY FOUNTAIN PENS

To prevent fountain pens leaking at the joints, place a small portion of common chewing gum at the joint only, but not on the threads. The gum should be chewed before using and applied while still warm. One application will be found sufficient, as it sticks to the surface. This does not appear to interfere with the removal of the part at any time and never leaks.—O. P. L.

MAKING SPRINGS IN THE LATHE

A quick and simple method of making springs in the lathe is shown in the accompanying illustration. A piece of steel of the required diameter is gripped in the lathe chuck, bored to the shape shown at *A*, and turned on the outside; it is then cut off from the bar. After this, two cast-iron washers *B* and *C* are fitted to this ring in the manner shown, and it is placed on an arbor. The arbor is placed in the milling machine and the ring is cut up into segments of the width de-



sired with a slitting saw, after which the rings *B* and *C* are removed and the cut segments are ground parallel. This method works very successfully in making springs, as shown at *D*, for ratchet feeds.

SUBSCRIBER

MENDING ARC LAMP GLOBES

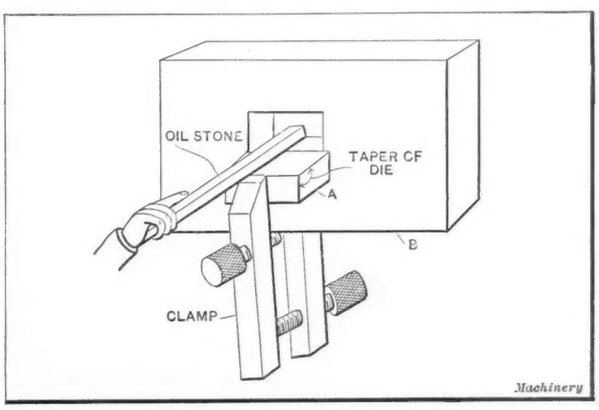
If arc lamp globes, as soon as cracks appear, are coated inside and out over the crack with silica of soda or "water glass," they may be prevented from further cracking or breaking, and thus prolong their usefulness.

The liquid glass should be spread on over the crack and allowed to dry before heat is applied, otherwise the water in the solution will "boil," thus making the "job" rough and blistered. But if allowed to dry, a hard glaze is formed when heated which binds the broken parts.

Salem, Ohio. H. W. WEISGERBER

METHOD OF STONING OUT A DIE

Stoning or lapping out a die is many times a tedious job and can be much more easily accomplished by the use of suitably placed guides or guards for the lap. As an example, consider a die, like the one shown in the accompanying illustration, having a square hole to be stoned out. First the out-



side of the die is ground as nearly parallel with two of the sides of the square hole in the die as possible. Then a block *A*, made of soft steel, having two sides beveled at the same angle as the die, is set parallel with surface *B* and at the correct height. During the lapping operation this block *A* will furnish a good guide for the lap. Sometimes if much lapping is to be done the block *A* will have to be removed and re-surfaced, as the stone will wear it slightly rounded.

DESIGNER

HOW AND WHY

DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST

Give details in full and name and address. The name and address will not be published with the answer.

WELDING CHROME-NICKEL STEEL

C. L. L.—I would like to know, through the columns of MACHINERY, how to weld chrome-nickel steel in an ordinary forge fire.

MAKING AND HEAT-TREATING WATCH SPRINGS

R. H. K.—How are watch and clock springs manufactured, and how are they hardened and tempered?

Answers to this question are solicited.

MAKING BRASS AND IRON TUBING

M. H. H.—How is the tubing used in bedstead manufacture made? Is the brass tubing made from cut sheets bent into the desired form and brazed? How is it formed and brazed, and how is iron tubing for the same purpose made?

Answers to this question are solicited from our readers.

UTILIZING REJECTED PARTS—REMOVING BURRS FROM METAL PRODUCTS

D. A. H.—What should be done with parts rejected by inspectors? Every plant accumulates rejected parts that do not come up to the standard in one way or another. Should these parts be thrown into the scrap pile, marketed as second quality, or treated individually so as to bring them up to the standard? What method of removing fins and burrs from manufactured metal products finds the greatest favor with manufacturers? Where small parts are made by the thousand the problem of cheaply and efficiently removing the burrs left by dies and cutters is serious.

STRAIGHTENING BRASS TUBING

T. M. W.—We have experienced considerable trouble in procuring brass tubing perfectly straight and true, and usually have to straighten it to make up rolls used in paper mill machinery. Our greatest trouble is with tubing 8 inches outside diameter, No. 8 Stubbs gage, hard and medium tempered, in lengths from 10 to 15 feet. We use this tubing for "carry rolls" on a paper machine and the face must be perfectly true to within 0.005 inch. We sometimes find short kinks and flat spots and the only method that we have been able to use is to center the tube in a lathe and peen out the kinks and curves by hand. We would be pleased if you could advise us of any method better than the one mentioned, or of a tube straightening machine suitable for the work.

A.—The defects are of a class that would seem most feasible to correct in a draw-bench, but a draw-bench of the size and power required for such heavy tubing would be a rather costly and cumbersome machine, and it would hardly pay to install it unless a large amount of tubing had to be straightened. We would be glad to receive suggestions or contributions from readers having experience with work of this sort.

SOLVING OBLIQUE-ANGLED TRIANGLES

G. E. H.—In solving a triangle, as shown in the accompanying illustration (Fig. 1), I find that the formula given in various handbooks is as follows:

$$c = \sqrt{a^2 + b^2 - 2ab\cos C}$$

I cannot obtain correct results by this formula, as it seems to me that the formula ought to read:

$$c = \sqrt{a^2 + b^2 + 2ab\cos C}$$

I assume that the formula as given in the handbooks is correct, but do not understand why it is. Will you explain this to me?

A.—The formula $c = \sqrt{a^2 + b^2 - 2ab\cos C}$ is the correct formula to use for solving any triangle in which two sides and the angle included by these two sides are known. The reason for the difficulty met with in the use of this formula is that the cosine for angles larger than 90 degrees is negative; hence, the whole expression $2ab\cos C$ becomes negative, and when a negative quantity is subtracted from another number, the effect is that of adding it, this being one of the fundamental rules relating to negative values.* An example will make this clearer.

* See also MACHINERY'S Reference Book No. 54, "Solution of Triangles," Chapter III, "Positive and Negative Quantities," and Chapter IX, "Solution of Oblique-Angled Triangles."

Assume that we are to find length of side c in the triangle shown by our correspondent (see Fig. 1). We then have:

$$c = \sqrt{1.5^2 + 1.5^2 - 2 \times 1.5 \times 1.5 \times \cos 110}$$
$$= \sqrt{2.25 + 2.25 - 2 \times 2.25 \times (-0.342)}$$
$$= \sqrt{4.5 - 4.5 \times (-0.342)}$$
$$= \sqrt{4.5 + 1.539} = \sqrt{6.039} = 2.46$$

If the angle is less than 90 degrees, then the cosine of the angle is a positive number and the numerical value of the whole expression $2ab\cos C$ will be subtracted as indicated by

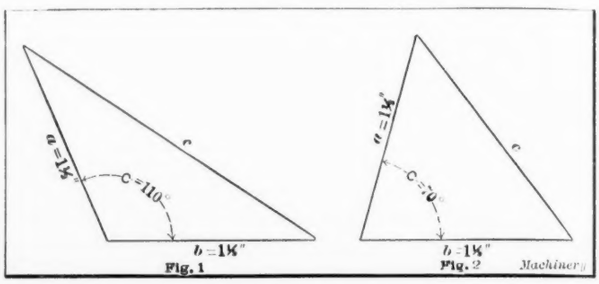


Fig. 1 Fig. 2

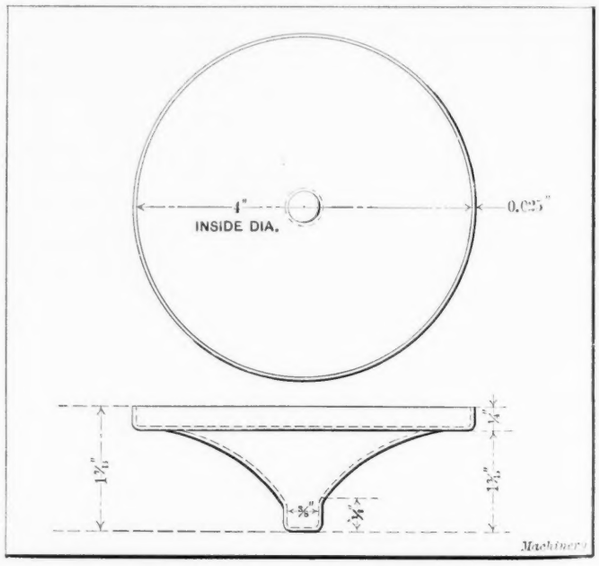
the formula. An example of this is given in the following, the angle C being assumed to be 70 degrees, instead of 110 degrees, as shown in Fig. 2.

$$c = \sqrt{1.5^2 + 1.5^2 - 2 \times 1.5 \times 1.5 \times \cos 70}$$
$$= \sqrt{4.5 - 4.5 \times 0.342}$$
$$= \sqrt{4.5 - 1.539} = \sqrt{2.961} = 1.72$$

By studying the preceding examples, it will be clear that the formula as given in the handbooks is correct for all triangles, irrespective of whether the angle between the two known sides is greater or less than 90 degrees, but as the cosine for angles larger than 90 degrees is negative, the actual numerical calculations involve the adding of the product $2ab\cos C$ to the quantity $a^2 + b^2$.

DRAWING AN ODD-SHAPED CUP

J. M.—The odd-shaped cup shown in the accompanying illustration is to be made from 0.025 inch sheet iron. The press available for this purpose is an ordinary geared Niagara



Falls press having a 2-inch stroke. What will be the size of the blank, how many operations will it require, and what are the successive sizes of the punches and dies?

Answers to this inquiry are solicited from our readers.

* * *

According to the *American Engineer and Railroad Journal*, Mr. W. B. Duff, a machinist, has recently, while turning a piece of vanadium steel, cut a spiral shaving that measured 155 feet in total length. This is believed to be the world's record in the making of long metal shavings. This achievement is, of course, more interesting than useful.

State University of Iowa
6 FEB 1912

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS
IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

THE HEALD INTERNAL GRINDING MACHINE

The internal grinding machine illustrated in Fig. 1 has been designed to meet the demand for a simple and inexpensive machine for grinding short holes in large numbers of duplicate parts. This grinder is built by the Heald Machine Co., 20 New Bond St., Worcester, Mass., and is known as the No. 75. It is recommended for work up to about 2 inches in length and is adapted for grinding such parts as transmission gears, bevel gears and pinions, bushings, milling cutters, rings, etc.

The principal novelty of this machine, as compared with the No. 70 style built by this company, is that the table is operated by hand instead of by an automatic power feed. The table movements are controlled by the large pilot wheel shown. Positive stops are provided which can be accurately set to govern the travel in either direction. This enables the operator to grind up to a shoulder or to any given point without danger of overrunning. On short work of the class mentioned,

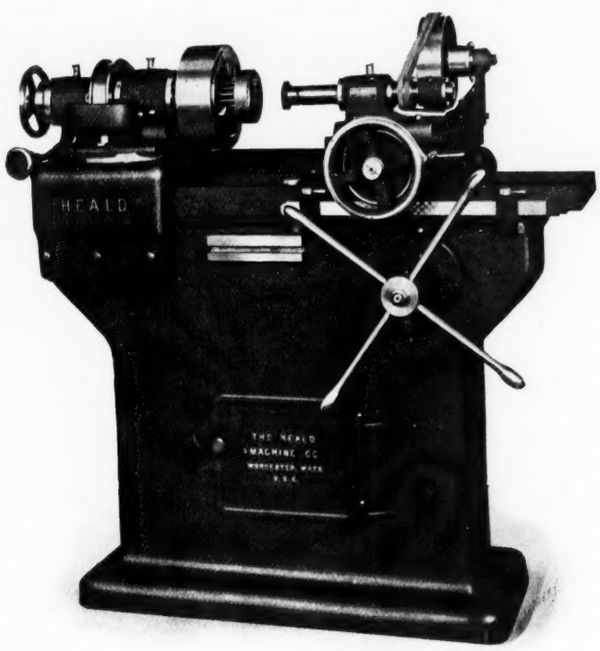


Fig. 1. Heald Internal Grinder with Hand-operated Table

the hand machine is said to be fully as rapid as the automatic; in fact, on short holes it has been found that the average operator can produce more work with a machine of the hand-feed type and without affecting the quality. The weight of the table and the ratio of the gearing connecting it to the pilot wheel, is such that a smooth uniform motion is obtained. After a hole is ground approximately to size, it is a very simple matter to back the wheel away from the work sufficiently to permit using a sizing block or micrometer. The wheel can also be quickly returned to the grinding position and no time is wasted in engaging or disengaging the power feed.

Another line of work in which this machine excels is in the grinding of holes which are recessed in the middle, as for example, a bushing having a bearing 1 or 2 inches long at each end and a space of larger diameter extending for say 2 or 3 inches between. With the automatic machine the wheel would feed through the first bearing surface and then proceed through the intervening space where no work was being done, until it reached the inner surface. Obviously, considerable time would be consumed without accomplishing any results. With the hand-feed machine, however, this idle period could be practically eliminated by traversing the wheel rapidly from the end of the first bearing surface to the beginning of the next. For work of this class the machine could be used for grinding parts which were 6, 7 or possibly 8 inches in length over all. A grinder of the automatic type is recommended for long holes or for grinding miscellaneous work which is likely to be either long or short.

The machine has a heavy rectangular base fitted with a heavy table having ample bearing surfaces. The ways are

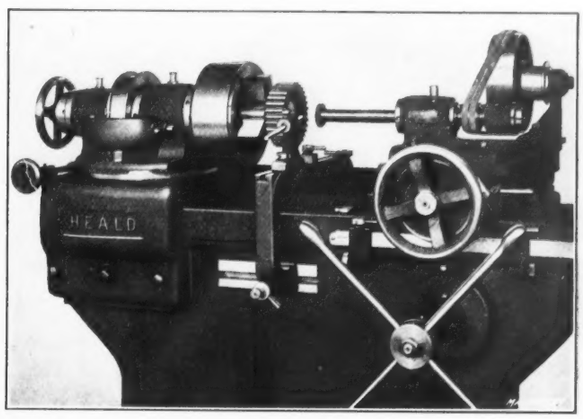


Fig. 2. Detail View of Heald Grinder

protected with guards to prevent the entrance of grit or dust and they have oil pockets with rolls for the uniform distribution of the lubricant. Many of the parts used in the hand-feed machine, such as wheel-heads, chucks, etc., are duplicates of those used in the automatic type and will interchange. Owing to this feature, one or two extra wheel-heads will be sufficient to handle various kinds of work in whichever style of machine can most conveniently be used.

The grinding spindle of this machine is mounted directly on the main table where it is rigidly supported. The headstock, a sectional view of which is shown in Fig. 4, is mounted on a heavy bridge casting and it is arranged to swivel to any angle up to 45 degrees either side of the center line. The graduations on the swivel base are both in degrees and inches

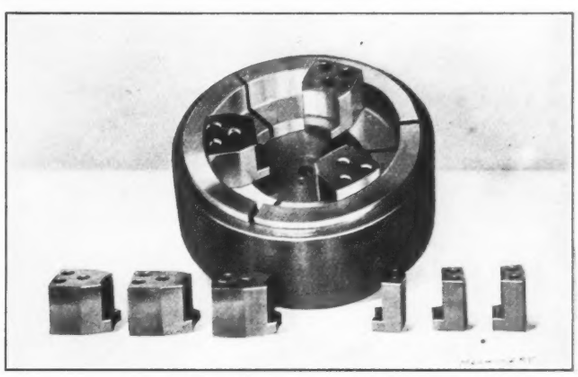


Fig. 3. Collet Chuck fitted with Solid Jaws

of taper per foot. The headstock is fitted with phosphor-bronze boxes made dustproof and adjustable for wear. The chuck spindle is of specially treated high carbon steel. It is ground and lapped and is of extra-large diameter in the bearings, the diameter of the front and rear bearings being, respectively, 2¾ and 2¼ inches. A hole 1¼ inch in diameter extends through the chuck spindle. This is used in connection with collet chucks and it is also convenient for exhausting dust when dry grinding, or for a water supply in connection with wet grinding.

The construction of the cross-slide and wheel-head is clearly

shown in the enlarged view Fig. 2. The idler pulley is fitted with radial ball bearings of the silent type and it is adjustable on the cross-slide for varying the belt tension. This pulley has two steps, the smaller of which is belted to the countershaft, and the larger to the wheel-spindle. With this drive the proper speeds for efficient grinding are obtained with a moderate speed of the countershaft. The bearings of the wheel-head are so arranged that endless belts can be put on and taken off quickly without making any adjustments. The wheel-heads are self-contained and interchangeable so the different sizes can be quickly substituted when changing from the grinding of large holes to small holes or *vice versa*. The pulley for each wheel-head is of the right diameter to drive

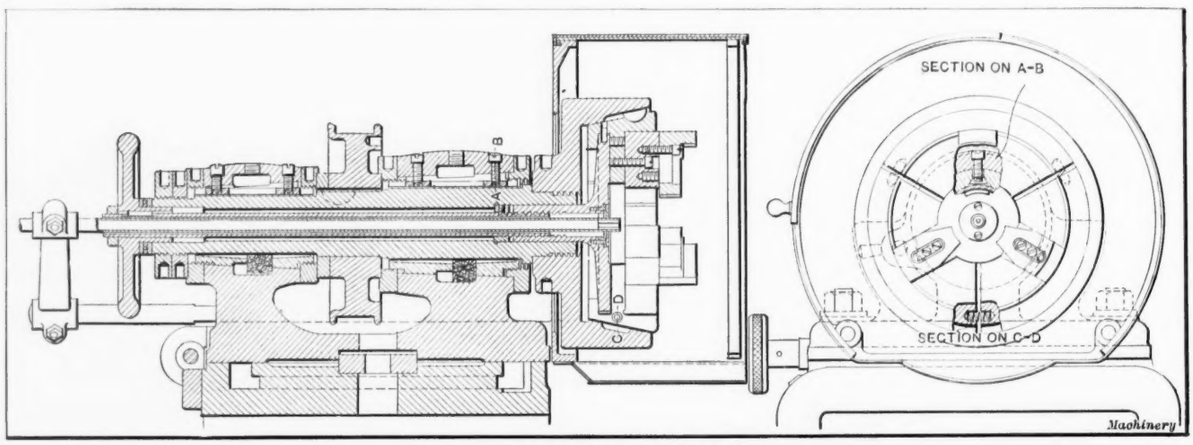


Fig. 4. Head and Collet Chuck—Heald Grinder

the grinding wheels used on that head at the correct speed, without attention on the part of the operator. An accurate adjustment of wheel speeds, to give the most efficient speed for new or old wheels, is made possible by different diameters on the spindle pulley. This machine is adapted for either dry or wet grinding. The table is equipped with water channels leading to a water pan connecting with a tank located on the floor in the rear of the machine.

A draw-in collet chuck designed to accurately locate work for internal grinding is shown in Fig. 3. This chuck is also shown in section in the assembly view of the swivel head, Fig. 4. It is operated by a handwheel at the left of the head in the usual manner. The collet can easily be fitted to hold odd-shaped parts which could not be held by jaws of the ordinary type. This chuck can be fitted with either solid or adjustable jaws, the former being shown in Fig. 3 and the latter in Fig. 4. The adjustable jaws are made in two parts and they have a capacity for diameters ranging from $\frac{5}{8}$ inch up to 8 inches.

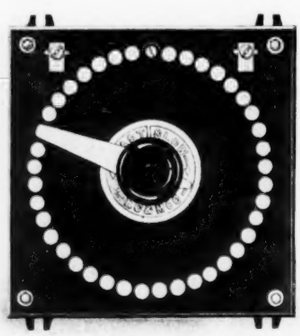


Fig. 1. Electric Controller & Mfg. Co.'s Motor Field Rheostat

ELECTRIC CONTROLLER MOTOR FIELD RHEOSTAT

The Electric Controller & Mfg. Co., Cleveland, O., has a new line of motor field rheostats for varying the speed of adjustable speed, shunt and compound direct-current motors. The construction of these rheostats, one of which is shown in Fig. 1, is fireproof throughout. The face carrying the arms and contacts is of the best quality Monson slate. The resistance units consist of small cast-iron grids insulated with asbestos and wound with resistance wire. These units are carried by the slate and are fastened directly to the contacts. The resistance wire has an unusually low temperature coefficient so that the resistance of the rheostat, for any one setting, does not increase with heating and thereby alter the speed of the motor which it regulates. A dial-plate with the words "fast and slow" on it, indicates which way to turn the rheostat handle to obtain the desired change in motor speed.

An important adjunct to these rheostats, known as a field rheostat relay, has been brought out. The combined rheostat and relay is shown in Fig. 2. It is well-known that a shunt or compound wound motor should be started from rest with full field strength. In fact, if the shunt field is weakened to a large extent, it may be impossible to accelerate the motor because of insufficient torque or a prohibitive sparking at the commutator. The admission of a large volume of current may also "blow" the fuses and circuit breakers. It is therefore the preferred practice to return the rheostat handle to the position of full field strength every time the motor is started. The field rheostat relay has been developed to prevent starting the motor with a weakened field.

This relay consists of a magnet coil or solenoid through which passes a steel plunger carrying at its lower end a disk-shaped contact plate for electrically connecting the two contact studs shown above it. The magnet coil and plunger are enclosed in an iron case which not only gives protection but also acts as a part of the magnetic circuit. The relay coil is connected in series with the armature circuit of the motor and the two contact studs are connected to the two terminals of the motor field rheostat so that the rheostatic resistance is short-circuited when the contact studs are bridged by the contact plate. The relay coil is so designed that when the armature current exceeds a predetermined maximum, the plunger is drawn up, thus bringing the contact plate against the studs and cutting out all of the resistance in series with the shunt field. This gives the motor its full field strength and consequently the maximum torque. As the current de-

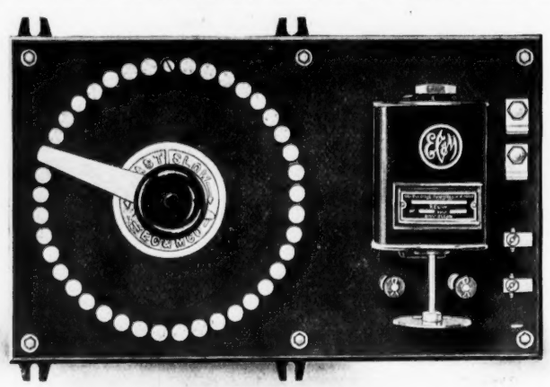


Fig. 2. Combined Motor Field Rheostat and Relay

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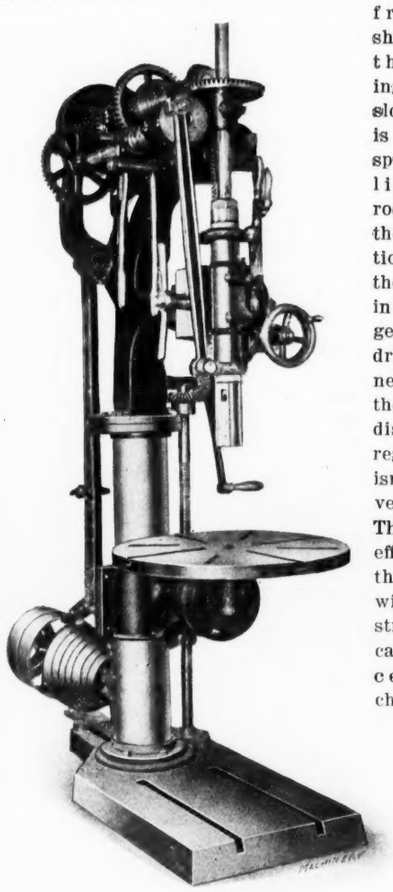
creases due to the speeding up of the motor, the relay plunger drops inserting the rheostatic resistance in the shunt field circuit and weakening the field. This cycle of operations is repeated until the motor has been safely brought to the proper speed as determined by the setting of the motor field rheostat.

The relay permits setting the field rheostat to give the most efficient motor speed for the work at hand, and no matter how often the motor is started and stopped, it will invariably run at this speed. It also saves the time of the operator who does not have to adjust the motor field rheostat after the motor is started. The motor field rheostat is furnished either with or without the field rheostat relay. It is rated up to and including 50 horsepower at 110, 220 and 550 volts and in general will provide for a maximum speed variation of 4 to 1.

DRILLING MACHINE WITH SPINDLE-RECIPROCATING ATTACHMENT

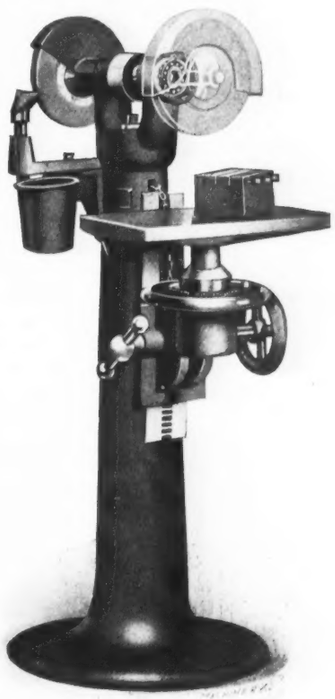
The upright drilling machine shown herewith is a novel design in that it can be used for keyseating and similar operations, in addition to drilling, the construction being such that the drill spindle can be given a reciprocating movement in addition to the rotary motion. This movement is obtained from a horizontal shaft at the top of the machine, carrying at one end a slotted crank which is connected to the spindle quill by a link or connecting-rod, as shown, when the reciprocating action is desired. When the machine is driven in this way, the back-gears for the rotary drive are placed in a neutral position, and the spindle quill is disengaged from the regular feed mechanism to permit the vertical movement. This disengagement is effected by throwing the worm out of mesh with its wheel. The stroke of the spindle can be varied within certain limits by changing the position of the crankpin with relation to the center of the crank. The machine can be quickly changed for drilling operations by simply disconnecting the rod and disengaging a clutch which connects the crank disk with the horizontal driving shaft. This clutch is controlled by one of the vertical levers shown at the left. The crankshaft is driven from the main driving shaft through spur gearing as shown. Aside from the reciprocating motion, this machine is similar in its general construction to the conventional upright drill press. It is equipped with a handwheel and lever feed, an automatic stop mechanism, and other features common to modern drill press design. The table differs from the usual type in that it can be tilted about a horizontal axis in order to accommodate angular work. This machine has been put on the market by W. J. Riordan & Co., Orange, N. J.



Drilling Machine the Spindle of which can be given a Rotary or a Reciprocating Movement

LA SALLE PLAIN AND SURFACE GRINDER

The La Salle Machine & Tool Co., La Salle, Ill., is now manufacturing a combined plain and surface grinder having ball bearings. It should be mentioned that this machine is not intended to supplant the design built by this company having plain "anti-friction" bearings. Particular attention has been given in the construction of this machine to protecting the working parts from dust or grit. Wheel guards are also provided to protect the operator. The knee and table are counterbalanced by a weight inside the column. The table is 8 by 14 inches and has a vertical travel of 12 inches on the guides with a ¾-inch adjustment by the micrometer wheel shown. This wheel carries a large dial graduated to thousandths of an inch and provides a fine adjustment for regulating the depth of cut. The opposite side of the machine is equipped for plain grinding, as the illustration shows. The distance between the grinding wheels is 15 inches and the height to the spindle center 40 inches.



La Salle Plain and Surface Grinder

HORTON INDEPENDENT CHUCK

The E. Horton & Son Co., Windsor Locks, Conn., is manufacturing a new design of independent chucks, two views of which are shown herewith. The body of this chuck is exceptionally heavy, and the jaws have wide gripping surfaces. The jaws are made of steel and are thoroughly casehardened; they have raised seats for the work to rest upon, and are ground true both on the face and gripping surfaces. The operating screws are of the best quality of steel for the purpose, and are of larger diameter than is ordinarily used; they are made to be flush with the body, and have mortised heads for the reception of the op-

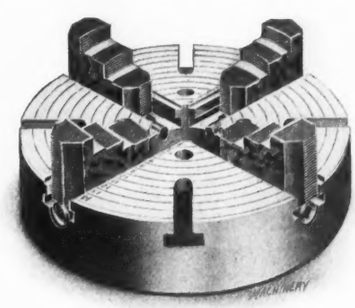


Fig. 1. Horton Independent Chuck, Model 50

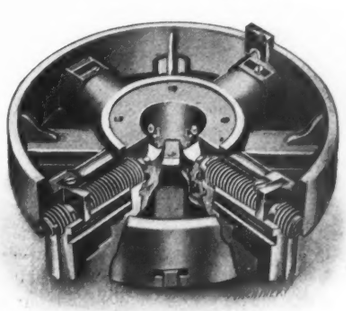


Fig. 2. Rear View showing Method of Inserting Steel Thrust Washers

erating wrench. The thrust bearings for the operating screws are of hardened steel and are removable. They are located at the place where they will sustain the greatest amount of strain when in operation, at which time this bearing is covered, preventing clogging with chips, etc. The location of these thrust bearings and the method of inserting them is clearly shown in the rear view, Fig. 2. A T-wrench of suitable size, having a hardened end, is furnished with each chuck. This design is made in sizes ranging from 6 inches to 42 inches, inclusive. This chuck, known as model 50, is not intended to supersede the other lines of independent chucks made by this company, but is an addition thereto.

NATCO ADJUSTABLE MULTIPLE SPINDLE DRILLING MACHINE

The National Automatic Tool Co., Richmond, Ind., has added to its line of multiple spindle drilling machines a smaller size, known as type M-1. This machine, in common with other multiple spindle machines built by this company, has independent speed changes for the different spindles, which makes it possible to vary the speeds of the drills in accordance with their diameter. The gears for effecting these speed changes are located inside the head and the positions of the change

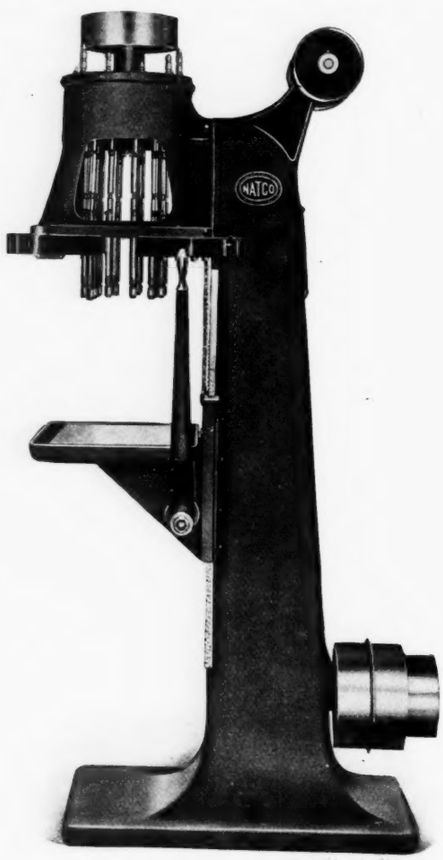


Fig. 1. Adjustable Multiple-spindle Drilling Machine, built by the National Automatic Tool Co.

gears are shown by the location of the grooved shafts seen extending above the head in Fig. 1. The shaft seen in the center is in the slow speed position, and those on either side are in a neutral position, whereas the outer shafts are set for high speed. By simply changing the position of these shafts, the speed of each spindle is independently controlled. The arrangement of the change gears is shown by the sectional view Fig. 2.

All gears are cut from the solid and no cast-iron gears are used. All head gears run in a continuous oil bath, the head acting as an oil reservoir. Ball bearings are used between the gears and all bearings are bushed with a special grade of phosphor-bronze. The adjustable steel spindle rails attached to the under side of the head are bronze bushed and have ball thrust bearings, adjustment for wear, ample oiling facilities and are made rigid to withstand any deflection. These rails can be quickly adjusted when changing the machine for drilling different parts. Spring collets are used for holding the drills which are clamped by hexagonal spindle caps screwed on the ends of the spindles. In case some of the spindles are not needed, they can be disengaged by placing the change gears in the neutral position. These changes can be made while the machine is running. The universal joints used in this machine have driving blocks with pins that are milled

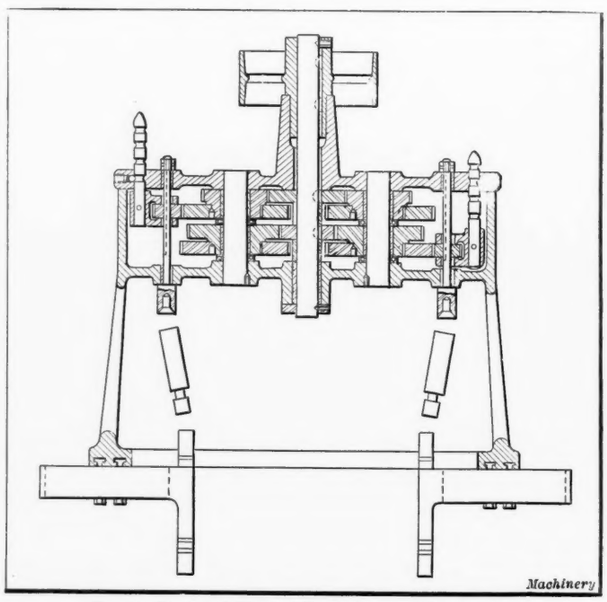


Fig. 2. Sectional View of Head showing Change Gears

from the solid. The wearing surfaces are also hardened, thus making a strong, durable joint.

These machines are built with either square or rectangular heads. The former has a drilling capacity of 9¼ by 9¼ inches between the drill centers and the latter, 12 by 18 inches between the centers. The square-head machine will take ten 5/16-inch straight shank drills, and the rectangular-head, sixteen 5/16-inch straight shank drills. The minimum center distance obtainable with either machine is 11/16 inch or 13/16 inch, depending on the diameter of the holes drilled.

The table is counterbalanced and has a large bearing surface on the column with an adjusting gib. Either hand or power feed can be furnished. Stops are located on the side of the column for drilling holes to any predetermined depth, and an automatic throw-out is supplied with the power feed. The distance from the top of the table to the lower end of the largest spindle is 21½ inches. The table on the smaller machine has a planed surface 10¾ by 14 inches, whereas the table of the larger machine has a planed surface 13 by 21 inches. These machines can be supplied with a single speed for the spindles in place of the double speeds, if desired.

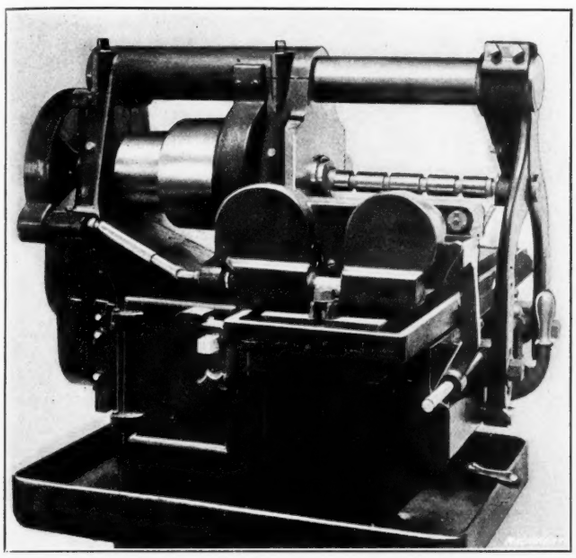
BICKFORD AUTOMATIC FLUTING MACHINE

In the department of New Machinery and Tools for June, 1911, we illustrated an automatic fluting machine built by the Bickford Machine Co., Greenfield, Mass. This company is now manufacturing a new design which has several distinctive features, aside from the indexing of the dividing head spindles and the table movement, both of which are entirely automatic as with the machine formerly illustrated.

The spindle of the machine is of crucible steel and runs in phosphor-bronze bearings arranged to provide for wear. The driving pulley is double back-geared with the spindle and is driven by a 4-inch belt. The knee is of the box type and is cast solid with the saddle. This machine has a combination drop arm and brace which are cast integral and give a very rigid support to the cutter arbor. The table is of large area and is surrounded by a channel to catch the lubricant. There

is also a large oil pan bolted between the base and the column to catch any overflow. The table has a rack and pinion type of feed and its reverse movement is obtained from a gear-box in the column of the machine. This box is so arranged that a slight rolling movement of a reverse shaft throws a sliding clutch and reverses the motion with a speed increase seven times greater than the cutting speed. The mechanism of this gear-box can be easily reached by opening a door in the column.

The work-spindles are connected by spur gears and they are operated through worm-gearing by a universal shaft equipped



Automatic Fluting Machine built by the Bickford Machine Co.

with a sliding clutch. The spindles are locked in position by an index disk and lever and the latter also controls the sliding clutch. At the end of the return movement of the table, a special trip dog throws this lever, unlocking the index disk and starting the worm. As the spindles revolve, a pin on the index lever drops in the next notch of the disk and throws out the sliding clutch. Separate indexing disks, hav-

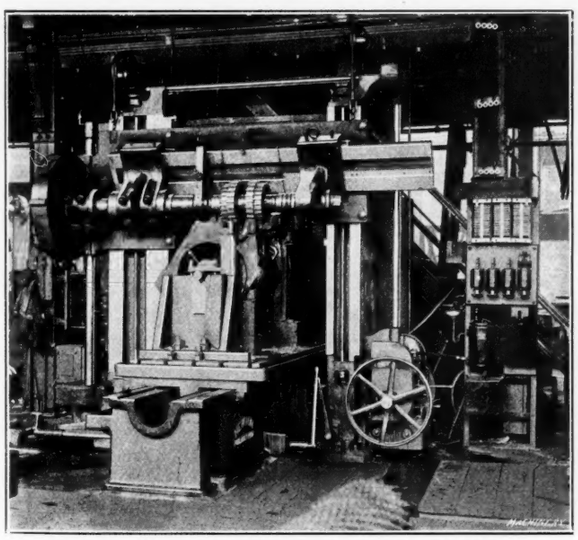


Fig. 1. Newton High-duty Planer Type Milling Machine

ing any number of notches from two to twenty-four, are furnished for varying the number of divisions.

The work-spindles in the tail-center block are equipped with heavy springs and are operated by levers, thus making it unnecessary to place the hands near the cutters when changing the work. A lever on the head-center block stops the feed when the work is completed. Only two levers are used for the table movements, one controlling the feed and one reversing the motion. A gear-driven pump attached to the rear of the machine, furnishes a flood of oil for each cutter.

NEWTON HORIZONTAL MILLING MACHINE

The planer type milling machine illustrated in Figs. 1 and 2 is an addition to the line of horizontal machines built by the Newton Machine Tool Works, Inc., Philadelphia, Pa. The illustrations show this machine milling the frame castings of street railway motors in the shops of the General Electric Co. The spindle is driven by large worm-gearing located on the left side. The driving worm is mounted on a vertical shaft which is connected by gearing with the driving motor as shown in Fig. 2. The diameter of the spindle in the saddle is 6⅜ inches and it revolves in bronze-bushed cap bearings. The cutter arbor is driven by means of a broad-face key, and provision is made for holding the arbor in place by a through retaining bolt. A cross hand adjustment is provided for setting the cutters laterally and the outer end of the cutter bar is supported by an outboard bearing having bushings with taper external bearings and adjusting nuts to compensate for wear. The cross-rail is of sufficient length to permit removing the cutters from the arbor without taking off the outboard bearing. The cross-rail is counterweighted and can be raised and lowered by power. The alignment of this rail is maintained by a single bearing on the left-hand upright. The work-table has an angular rack and spiral gear drive with nine changes of geared feed, ranging from ½ inch to 8 inches per minute, which is available in both directions. It also

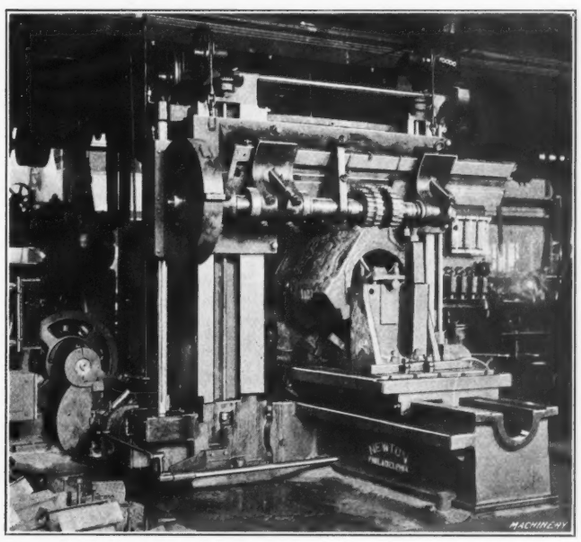


Fig. 2. Another View of Newton Machine showing Driving Motor

has a fast power traverse. The minimum distance from the center of the spindle to the top of the work-table is 5 inches and the maximum distance 31 inches. The work-table is 36 inches wide and work 12 feet in length can be milled.

WESTINGHOUSE CRANE CONTROLLER

The well-known "grindstone" type of controller which is used extensively in connection with direct-current motors operating cranes, hoists, steel mill machinery, etc., consists essentially of a cast-iron frame on which is mounted a stationary disk carrying the contact pieces and cross connections. Pivoted to the center of the disk is the switch arm with four brush-holders. The resistors can either be mounted on the frame or separately.

As a result of a series of experiments, the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., has recently placed on the market controllers of this type in which the disk is made of concrete instead of stone. By a special treatment, the concrete disk is made a thorough non-conductor and at the same time moisture resisting. The use of concrete permits the cross connections between the segments to be made within the body of the disk, thereby giving the latter a "reinforced" concrete construction and, at the same time, producing a more compact apparatus. The concrete disk with

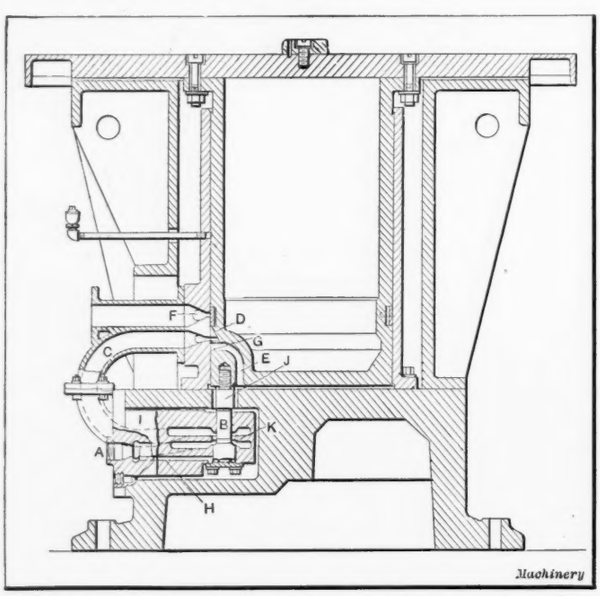
its self-contained cross connections also gives the controller a neat appearance. Two views of the new concrete "grindstone" controller are shown herewith. In this particular piece of apparatus, the resistors are separate and not shown. The contact pieces are attached to the disk by screws as with the older type and they are as easily renewed. A blow-

Westinghouse Grindstone Type Crane Controller

out coil of asbestos insulated wire is mounted on each brush-holder to disrupt the arc formed in opening circuits.

MUMFORD VALVE FOR JOLT RAMMING MACHINES

Owing to the severe shocks to which jolt ramming machines are continually subjected when in operation, a simple and durable construction is especially desirable for machines of



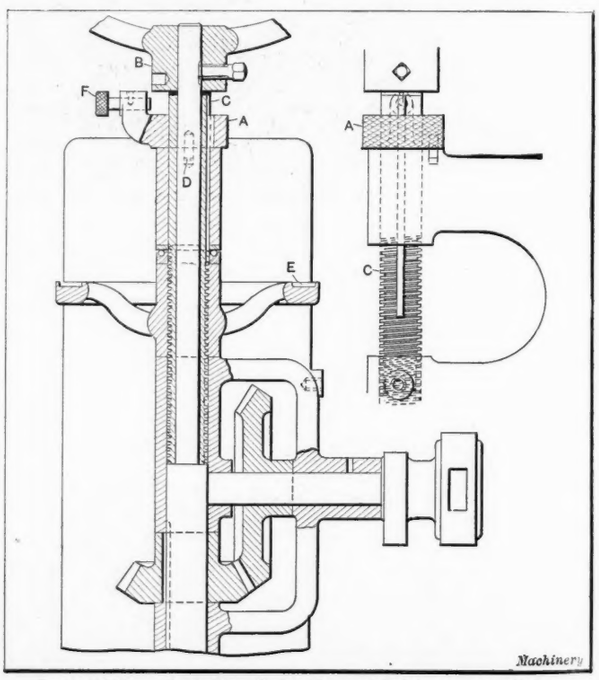
Sectional View of Jolt Ramming Machine with New Mumford Air Valve

this class. The Mumford Molding Machine Co., 30 Church St., New York, in order to simplify its ramming machines as far as practicable, has brought out a new air valve which consists of a single moving piece, actuated by the air it controls.

The arrangement of this valve is shown by the accompanying sectional view of a 24-inch machine having a 72- by 72-inch table. When the machine is in operation, the action of the valve is as follows: The air enters at *A* and passes around the stem of valve *B* to the tube *C*. From this tube it enters a space inside of the main plunger at *D* and is then admitted through port *E* to the under side of the main plunger which, with its mold table, is raised. When the lower edge of the packing ring on the main plunger uncovers exhaust port *F*, the edge *G* of the plunger has risen far enough to obstruct the entering air. With the exhaust open and the air supply shut off, the pressure under the main plunger is rapidly reduced. While the table is falling, valve *B* is forced up against the reduced pressure in the cylinder and positively closes the entrance of air. Valve *B* is forced up by the "line pressure" introduced through the by-pass *H* and this pressure holds *B* up with the air shut off until just before the point of impact, when the projecting part *J* of the main plunger pushes valve *B* open and re-admits air for the next stroke. From this it will be seen that the valve is actuated by the air independently of the velocity of the rising table and without imposing any burden upon the entering air column. This valve is said to be sure in its operation and the total absence of springs and delicate parts insure durability. The valve is carried in plug *I* which can readily be removed if necessary.

QUICK-RETURN MECHANISM FOR WILEY & RUSSELL DRILLING MACHINES

The simple form of quick-return mechanism illustrated by the accompanying sectional view, is applied to the post type drilling machines built by the Wiley & Russell Mfg. Co., Greenfield, Mass. This mechanism is so arranged that when the



Sectional View illustrating Simple Form of Quick-return applied to Wiley & Russell Hand Drilling Machines

collar *A* is engaged with balance-wheel *B*, the spindle may be quickly raised or lowered in either direction, by simply turning the regular operating crank. This is a decided improvement over the handwheel which is ordinarily used for raising and lowering the spindle on machines of this class.

The action of this quick-return mechanism is as follows: While the machine is drilling, collar *A*, which is splined to the threaded quill *C*, is locked by the engagement of pin *D* with a hole in the main frame of the machine. The quill is then prevented from rotating and it is slowly fed downward by ratchet-wheel *E*, which is threaded to it as shown. In order to engage the quick-return movement, collar *A* is raised and sliding pin *F* is inserted in a hole in the balance-wheel hub. The latter with the spindle is then locked to the quill which is screwed rapidly through the hub of the ratchet-wheel in either direction, by turning the driving crank. The detail view to the right shows the spline which prevents any rotary movement between the collar *A* and the quill. By this simple means the spindle can be rapidly raised or lowered to any position within the full range of the machine.

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THE SPIRO STEAM TURBINE

A new type of steam turbine, which is unique because of its simple construction and efficient as a prime mover, has been developed by Mr. John H. Van Deventer, superintendent of the Buffalo Forge Co., Buffalo, N. Y. One of the striking features of this turbine is its small size, considering the power developed. Fig. 1 shows a 185 horsepower unit which has been used for the last three years for driving fans, gas scrubbers and other apparatus. We are informed by the builders that this turbine has not been apart or had a single adjustment made since its installation. The power of this turbine, namely 185 horsepower, was developed with 100 pounds initial pressure which is the standard by which all the turbines built by this company will be rated.

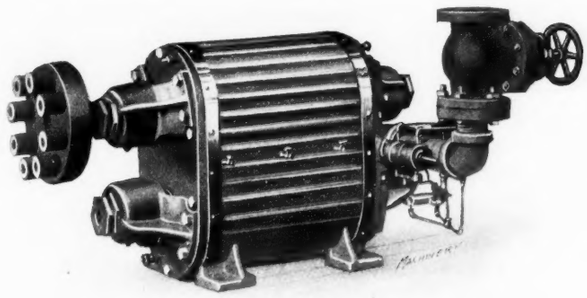

Fig. 1. One Hundred and Eighty-five Horsepower Steam Turbine built by Buffalo Forge Co.

This type of turbine consists principally of two rotors in the form of herringbone gears which are contained in a cylinder having suitable heads and bearings. The rotors are shown

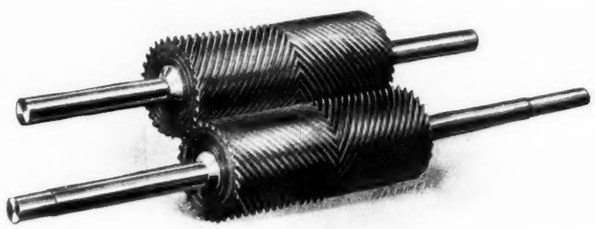

Fig. 2. Rotors of the Spiro Turbine

in detail in Fig. 2 and the cylinder and cylinder heads in Fig. 3. When the turbine is in operation, the steam is admitted to the central pocket formed by the right- and left-hand spiral teeth of each rotor, from a double port located at *A* in the center of the V-shaped rib which extends across the cylinder. The rotors, which are accurately fitted and mounted with relation to the cylinder bore, revolve outward from this central steam port. When any given tooth space has passed this port, the steam is automatically cut off, after which it expands in the spiral groove as the rotor continues to revolve, until the end of the groove is reached. As the apexes formed by the spiral grooves come opposite the exhaust port on the upper side of the cylinder (in this particular case), the steam exhausts into the atmosphere. The expansion of the steam takes places at a high velocity owing to the angularity of the rotor teeth and the peripheral speed, and as the steam enters every groove in the circumference of each rotor during a revolution, there are a great many expansions per minute. It will be seen that the length of the port determines the point of cut-off and, consequently, the ratio of expansion, so that any predetermined ratio can be obtained by changing the port construction. The size of this port could also be automatically varied by a governor, though the turbine illustrated in Fig. 1 is not so equipped.

The action of the "Spiro" turbine is said to be practically noiseless, the only sound being a slight hum similar to that of an electric motor. There is also very little vibration, and foundation bolts are not necessary for direct-connected units. The teeth of the rotors are accurately cut, and metal-to-metal contact is said to be prevented by a film of steam which cushions the teeth. The length of these rotors is much greater than would be necessary for spiral gears transmitting equal loads at equal speeds and, consequently, the maximum tooth pressure per square inch is limited to five pounds, which is much less than would be applied to gears for transmitting power. The lubricating system of the bearings is so designed that each bearing acts as an individual oil pump, circulating oil through the bearing between the shaft and bushing with positive pressure. This forms an oil film which is automatically maintained as long as there is any oil in the reservoir which forms a part of each bearing.

Fig. 4 shows a turbine of 10 horsepower capacity that is directly connected to a 25-inch fan which, at present, is furnishing forced draft through Jones underfeed stokers for a 300 horsepower boiler. These turbines are said to be highly adapted to fan service as the high rotative speeds enable the size of the outfit to be reduced to a minimum. When the turbines are coupled to fans having a constant load, no governor is used, but for variable loads, a sensitive quick-acting governor is provided. These turbines are also applicable to the driving of centrifugal pumps, for auxiliary service on shipboard where economy of space is so important, and for many other obvious purposes. The starting torque is high and the maximum speed quickly obtained.

Fig. 3. Cylinder and Heads of Spiro Turbine

Tests made on two turbines of this type show the following results: (1) Capacity of turbine, 25.3 horsepower; boiler pressure, 120 pounds; initial pressure, 101.5 pounds; speed, 2450 revolutions per minute; water per brake horsepower, 53.2 pounds (non-condensing). (2) Horsepower, 151; boiler pressure, 130 pounds; initial pressure, 115 pounds; speed, 2710 revolutions per minute; water per brake horsepower, 31.8 pounds (non-condensing). These turbines are at present

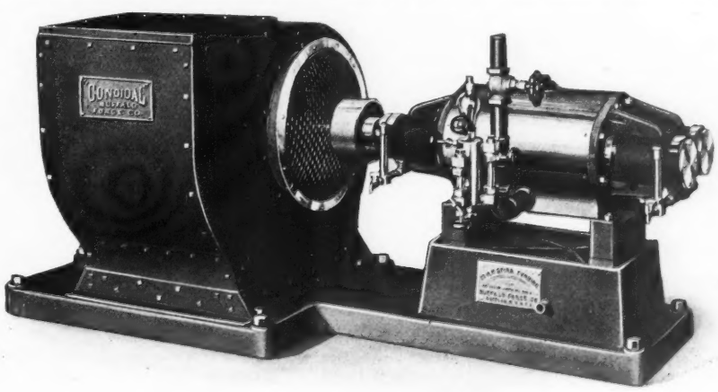

Fig. 4. Ten Horsepower Turbine coupled to 25-inch Fan

manufactured in sizes ranging from 1 to 50 horsepower, non-condensing, and capacities up to 300 horsepower are in process of manufacture.

WATSON-STILLMAN SHEET-METAL SCRAP BALING PRESS

Scrap from sheet iron such as is used in the manufacture of electric motors can be increased in value about six dollars per ton by compressing it into bales, because of the greater convenience in handling. The illustrations show a press and its operating system recently designed for the baling of scrap sheet metal by the Watson-Stillman Co., 192 Fulton St., New York. This particular type, which was installed by the General Electric Co., takes scrap from the floor, compresses it, pushes the bale out and drops it beneath the floor onto a runway. From the end of this runway the bale can be dumped onto an elevator from which it can be delivered by another runway to a freight car. With suitable pump and accumulator service, this press forms from fifteen to twenty-five bales (from two to three tons of material) per hour, the output depending upon the skill of the operator.

The press is approximately twenty-three feet long, four and one-half feet wide, and it is set in a pit about six feet deep and rests on pedestals to give room for repairs if necessary. The working parts consist of a scrap or pressing box, the top of which is flush with the operating floor line, and which has a hydraulically operated cover and two opposed hydraulic cylinders. One of these closes the box and the other compresses the bale and pushes it out. The pressing box is 60 inches long by 20 inches wide by 30 inches deep, which depth is reduced to 10 inches by the closing of the cover. The larger of the cylinders (seen at the left in Fig. 1) closes the front end of the press, and at the same time acts as a lock to the cover when it is closed. This cylinder is controlled by the same valve as the main or compressing cylinder at the right. The compressing cylinder is double-acting. Pressure is supplied to the closing cylinder and the working end of the compressing cylinder from a variable-pressure, belted, hydraulic pump. This pump has large pistons which deliver pressure up to 1500 pounds per square inch and it is automatically stopped as the pressure goes above the figure mentioned. Pressure for the cover-closing cylinder and for pulling back the ram of the compression cylinder is furnished at 1500 pounds per square inch from an accumulator, served by a separate small pump, and loaded with about fifteen tons of pig iron.

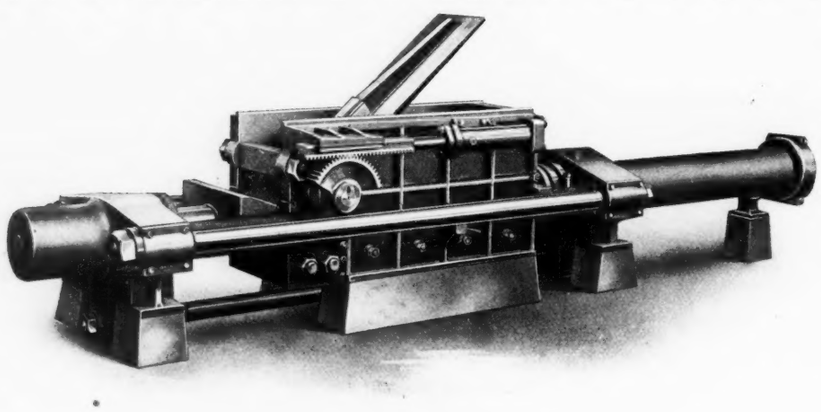

Fig. 1. Watson-Stillman Hydraulic Baling Press

In service, the action of the press is as follows: About 250 pounds of material are shoveled into the box and the valve *A*, Fig. 2, is moved. This admits accumulator pressure to the cover cylinder, forces its ram outward and closes the cover through the rack and segment pinion seen in Fig. 1. One movement of the valve *B* then puts pump service simultaneously upon both closing and compressing cylinders. This sends the ram of the closing cylinder forward which locks the box cover in the closed position when the limit of travel is reached; then as the pump pressure in the outer end of the compressing cylinder goes above and overcomes the accumulator pressure in the pull-back end of the cylinder, the compressing ram moves forward until the pump pressure reaches the maximum of 4900 pounds per square inch. The parts are so proportioned that this gives a total finishing pressure of 200 tons upon the bale, which reduces its dimensions to about twenty inches by ten inches by ten inches and makes it so compact that no straps are required. A second movement of the valve *B* releases the forward pressure in the closing cylinder, thus permitting the compressing cylinder ram to continue pushing the bale to the left and out of the press, and at the same time returning the closing cylinder ram to its initial position. A third and final movement of the valve *B* then releases the forward pressure on the compressing cylinder ram, the bale drops down into the delivery chute, and the accumulator pressure, which has been constantly acting on the return end of the compressing cylinder ram, returns the latter to the initial position.

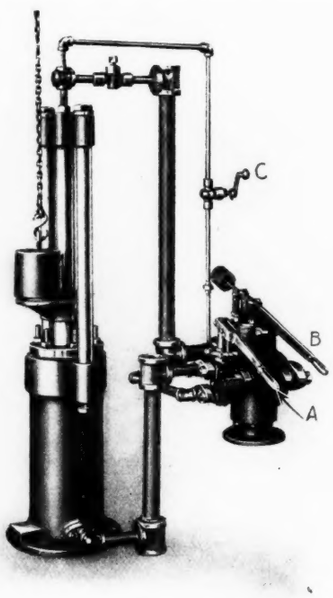

Fig. 2. Safety Governor for Baling Press

Protection from harmful over-pressure is provided by the safety governor at the left in Fig. 2, which shuts off the pump at the limiting pressure. This governor has two cylinders with pistons of different diameters. The larger at the bottom is in direct contact with the accumulator pressure of 1500 pounds per square inch. The smaller piston is directly connected to the discharge pipe of the large automatic variable pump. As the accumulator pressure is constant on the larger piston, the shelf supporting the weight is normally in its highest position. The pump then discharges through the large operating valve either to the press cylinders, or back to the reservoir. When the valve is set for admission to the press cylinders, pressure in the top part of the governor is gradually increased. As the bale compresses, the low-pressure plungers are first thrown out automatically, after which the two high-pressure pistons continue the work until the maximum pressure of 4900 pounds per square inch is reached. When this happens, the 4900 pounds pressure also acting on the top or small cylinder of the governor, overcomes the pressure in the other end, forces the piston with the shelf downward, releases the weight, and causes the high-pressure plungers of the pump to be by-passed. By opening the small valve *C* shown in the vertical pipe line, the pump is started again.

Where desirable to deliver the finished bale onto the operating floor, a three-cylinder construction is necessary, the extra cylinder being placed vertically under the bale, and the upper end forming the bottom of the baling box. The dimensions and the method of operating can, of course, be varied.

LANGELIER AUTOMATIC DRILLING AND FORMING MACHINE

One of the special automatic machines designed and built by the Langelier Mfg. Co., Providence, R. I., is shown in Figs.

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1 and 2. Fig. 1 shows the front or operating side of the machine and Fig. 2 is a rear view. The purpose of this machine is to automatically round or chamfer both ends of round rods and also to drill, simultaneously, a cotter-pin hole crosswise near each end of the rod. The machine can be adjusted to handle rods from ¼ to ½ inch in diameter and from 3 inches to 13½ inches in length. The output for rods of 5/16-inch diameter is 3½ per minute.

The horizontal bed of this machine has along its entire length a dovetailed slide on which the crossheads that carry the drilling and end-forming spindles, as well as the feed hoppers, are located. The left-hand crosshead is stationary and is fastened permanently on the end of the bed. The right-hand crosshead can be adjusted along the bed to accommodate rods of different lengths. The main cam-shaft from which the various movements are obtained, is mounted horizontally midway between the oil pan base and the dovetailed slide. This shaft is driven by a friction-ring clutch pulley through a worm and gear, as shown. The drilling heads, which are shown in the rear view, are attached to each of the crossheads. The feeding movements for the drill spindles are obtained from a horizontal shaft connecting both drill heads, upon which is fastened segment gears meshing with racks cut into the yokes of each head. The shaft obtains its movement through a cam lever engaging the inner face of the large face-cam seen to the right of the machine, Fig. 2. This rear shaft

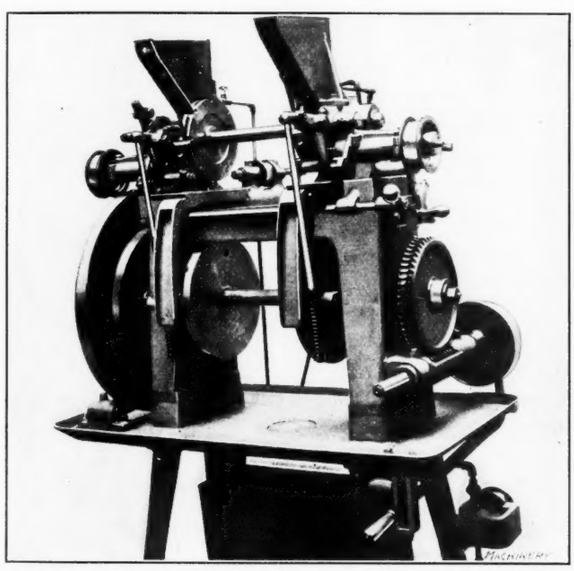


Fig. 1. Langelier Automatic Rod-drilling and End-forming Machine

also carries two segment cams for actuating the feed for the end-forming spindles.

The hopper feed consists of two triangular end guides located above the notched carrier disks. The latter are mounted on a shaft having bearings through each crosshead. This shaft derives its motion from a pawl and ratchet wheel linked to the outer face of the large face cam. The notched carrier disks, in passing the opening in the hopper guides, allow the rods in the hopper to fall into the notches in the disks which, in turn, carry them to their respective drilling and end-forming positions. Each carrier disk has a rectangular slot cut into its outer face to allow the ends of vises to enter and bind the rod firmly while being drilled. These vises are located at the lowest notch position directly under the center of the disks and are actuated by the two face cams mounted on the main cam-shaft between the legs of the frame. These vises also serve as jigs for drilling the cross holes in the rod accurately. The end-forming spindles are located on the front and the third notch up from the drilling position. Alligator jaws fulcrumed to a bellcrank lever and actuated from the cam-shaft, are provided to hold the rods firmly while being operated on. The end-forming spindles run in opposite directions and neutralize the turning effect on the rods. All connections to the feed disks are flexible, so as to prevent any breakage, in case the rods should happen to clog in the hopper and not enter the notches properly. After the drilling and end-forming operations are performed, the rods are carried up and ejected at the front of the machine.

An automatic oil pump is used to force oil to the cutting tools. The oil and chips fall in cavities cast in the base of the crossheads. The oil is separated from the chips and falls into the lower oil pan where it is again filtered before entering the oil tank. The machine clutch pulley, drilling and end-forming spindles, are each belted separately to an overhead

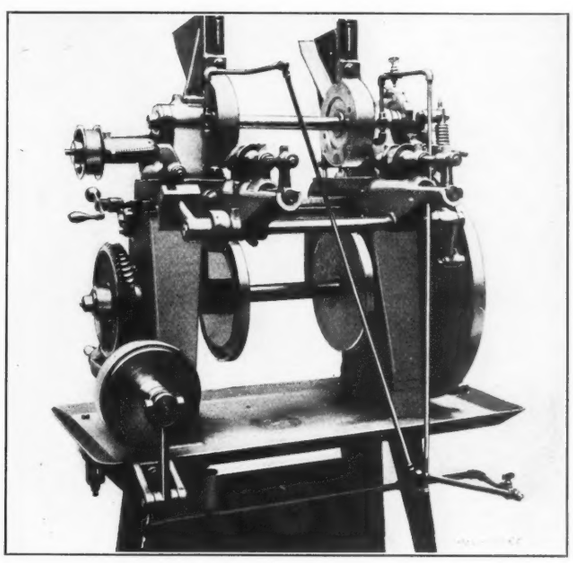
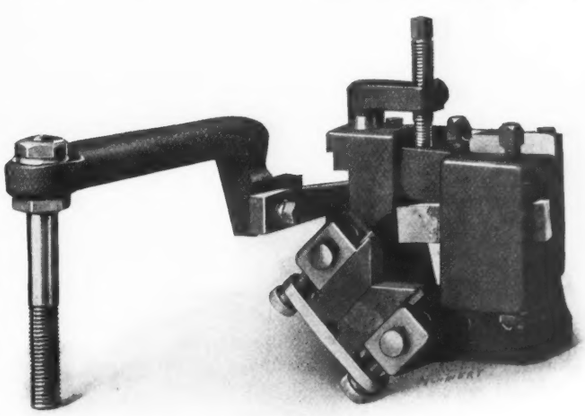


Fig. 2. Rear View of Langelier Machine

countershaft. The action of the machine is absolutely continuous and automatic. The hopper is of sufficient capacity to run one hour without refilling.

ACME TAPER TURNING TOOL

The taper turning tool illustrated herewith is so arranged that the taper bar or templet which controls the movement of the turning tool, forces the cutter out from the center of the work in a positive manner, and insures the proper taper.



Acme Taper Turning Tool

This design differs in this respect from the type which depends on a spring to force the tool out against the taper bar. With the latter construction there is nothing to prevent the tool from gouging into the work, but any trouble from this cause is completely eliminated with the improved construction shown in the illustration. The cutter is mounted in a vertical slide connected by means of the long adjustment screw shown, to an L-shaped piece with which the taper bar engages. The pressure of the cut and a small spring holds the tool firmly against the taper guide. The bracket carrying this guide or templet is held in position by a bolt at the left end, which is screwed into the head-cap of the machine. The back-rest

precedes the cutting tool and bears against the straight part of the work. This tool is a design of the Acme Machine Tool Co., Cincinnati, O.

KEARNEY & TRECKER VERTICAL SPINDLE MILLING MACHINE

The Kearney & Trecker Co., Milwaukee, Wis., is the builder of the vertical spindle milling machine shown in Fig. 1. This machine is similar in many respects to the horizontal type

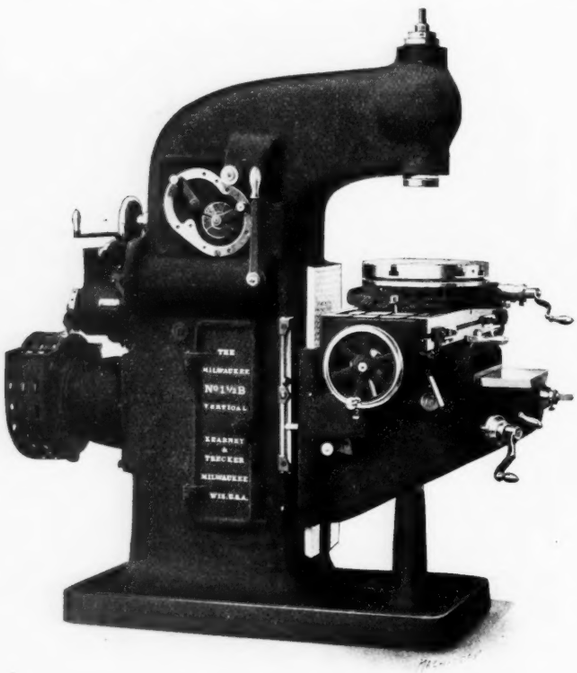


Fig. 1. Vertical Milling Machine built by Kearney & Trecker Co.

made by this company, the changes in the feed and driving mechanism, aside from the drive to the vertical spindle, being confined to differences in dimensions. The spindle of this machine is non-adjustable, the knee being depended upon entirely for vertical adjustment, which is a departure from the usual custom in the design of vertical spindle machines of the knee type. This construction was adopted because the experience of the builders has shown that with machines of the heavier type more is lost than gained by using the adjustable spindle, as the latter is less rigid than the fixed non-adjustable type.

The sectional view, Fig. 2, shows clearly the arrangement of the spindle driving mechanism and its lubricating system. The boxes are of bronze and the spindle has a taper bearing on the lower end and a taper sliding sleeve on the upper end which enables wear to be taken up by the collar shown. The lubricating oil for the driving gears and spindle is pumped upward through pipe *A* by a pump of the spur gear type, located in the base of the machine. This pipe delivers the oil to the perforated distributing pipe *B* which lubricates thoroughly all the horizontal bearings and gears, these being so constructed that the oil "cascades" downward from one bearing to another. It will be noted that these bearings are grooved in such a way that the oil can flow freely through them. This prevents any foreign substance that might be in the oil from lodging in the bearings, the rapid flow washing out any such impurities. The surplus oil flows into the passage *D* through a hole *C* drilled in the main casting. Engaging with this passage there is a horizontal hole *E* connecting with the vertical hole *F*. The latter is plugged at the top, the object being to provide an overflow of the surplus oil so that, in effect, a reservoir is maintained in contact with the upper bearings at the height of the hole *E*. The surplus oil flowing through *F* discharges onto gear *G*, lubricating it thoroughly, and then flows downward through the horizontal bearings at the front of the machine, overflowing successively each pocket and cascading downward the same as for the back bearings.

The grooves in the upper spindle box are so constructed that the oil is carried upward into the annular groove *H*, thoroughly lubricating both thrust collars and bearings. The oil discharged from the gear *G*, flows through the lower spindle bearing onto the collar *I* and is prevented from running downward over the end of the spindle by the collar *J* which is made oil-tight in the main frame of the machine. The front end of this spindle is of the company's flanged construction having a hardened steel driving collar that can be removed, thus permitting face milling cutters to be screwed solidly against the flat face of the spindle which is always protected from injury by the hardened collar referred to and therefore maintains its accuracy.

This machine has eighteen spindle speeds, varying in geometrical progression, and ranging from 15 to 354 revolutions per minute. These eighteen speeds are obtained by the use of ten gears only. One of these gears is located on shaft *K* and engages with the middle step of the three-step cone *L* which is an idler carried in the swinging frame *M*. This frame is supported on one side by shaft *K* and on the opposite side by a pinion, so that there is no overhang whatever to the idler *L*. The three steps in the idler *L* are arranged so that they can be engaged successively with the gears *N* and *O* which gives six changes of speed. The spindle sleeve gears *P* and *Q* are arranged to engage with *O* and *N* and also slide into engagement with the pin *R* on the large driving gear *S*, which engages with the pinion *T* for slow rotative speeds. This gives three changes of speeds which, combined with the six obtained through the medium of the cone *L*, makes a total of eighteen changes obtained by the use of ten gears, as mentioned.

The machine has an automatic table feed of 24 inches and an automatic cross-feed of 12 inches. The work-table can be

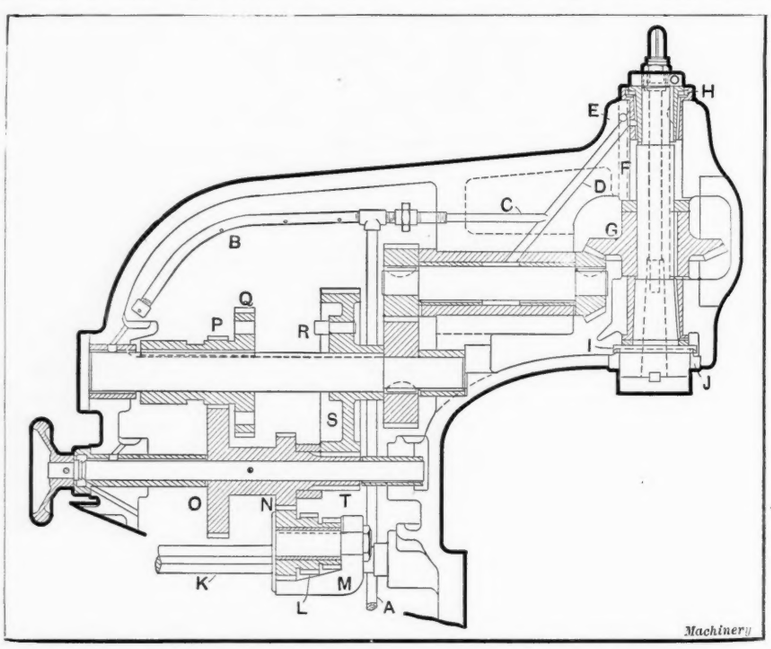


Fig. 2. View showing Driving Gears and Lubricating System of Vertical Milling Machine

lowered 18½ inches from the end of the spindle and the vertical feed is automatic. The table has a working surface of 11½ by 38⅜ inches. The rotary table is 14 inches in diameter on the working surface, 18 inches diameter over the

oil pan and is 5 inches high. The driving pulley is 14 inches in diameter for a 4-inch belt, and runs 250 revolutions per minute. The pulley is guarded by a neatly designed guard that is made of perforated sheet metal and is so constructed that it can be turned to any angular position around the pulley. This feature makes it possible to place the belt at any angle. No countershaft is needed with this machine.

GARVIN NO. 22 MONITOR LATHE

The monitor lathe shown herewith is built by the Garvin Machine Co., Spring & Varick Sts., New York. This machine is equipped with automatic power feed for the turret slide, an improved turret mechanism, and an automatic chuck equipment. The power feed is automatically tripped by individual stops controlled by the rotation of the turret. The automatic

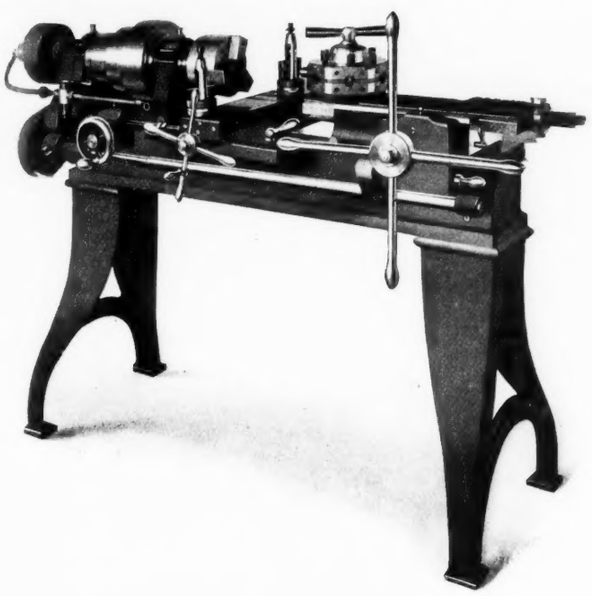


Fig. 1. Garvin No. 22 Monitor Lathe

chuck reduces the time required for inserting and removing the work. The air cylinder for operating this chuck is located at the rear end of the spindle. When air pressure is admitted to this cylinder, the chuck jaws are operated by a piston and multiple wedge mechanism. The chuck illustrated is known as the 6-inch adjustable blank-jaw type. The gripping power

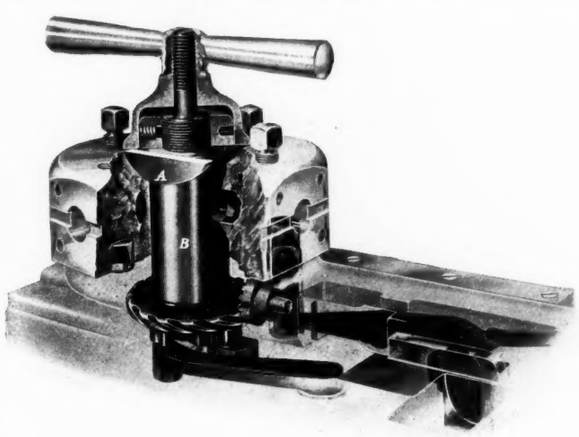


Fig. 2. Turret of Garvin Lathe

of the jaws is controlled entirely by the air pressure used. When machining delicate parts, the proper reduction of grip can be obtained by placing a reducing pressure valve in the line of pipe connecting the source of supply and the operating valve. The latter is located in front of the headstock. A spring-operating mechanism can be supplied for factories not equipped with air pressure.

The gripping power of the three-jawed chuck operated by a heavy spiral spring, was shown by a recent demonstration. The chuck used was a 9-inch size fitted to a geared-head turret lathe of standard make. A machine-steel disk, 8 inches in diameter and 1 inch thick, cut from bar stock, was inserted in the chuck jaws and a 1¾-inch high-speed twist drill was forced through this plate. A grooving tool ¾ inch wide was then sunk into the face of the blank on a circle 7 inches in diameter, to a depth of ½ inch. This was followed by a third operation in which the cross-slide tool took a 3/16-inch cut across the entire face of the blank. The back-gears were used to obtain the full belt power and the belt frequently slipped, showing that the grip of the chuck jaws was up to the full belt power of the machine.

The pressure for closing the chuck jaws automatically releases a brake and starts the rotation of the spindle. The removal of the pressure, whether air or a spring is used, stops the rotation and opens the chuck jaws to their full limit. In addition to the three-jawed chuck referred to, two-jawed types of various sizes and styles are furnished.

As will be seen by referring to Fig. 2, the turret is of hexagonal shape, there being six flat surfaces with four cap-screw holes for securing rigidly either tools or fixtures. The turret rotator *B*, as now furnished on Garvin monitor lathes, is made of one piece as shown. It is hardened and ground on the cylindrical fit and is secured to the rotating turret by two Woodruff keys *A*.

STANDARD MACHINERY CO.'S STOCK STRAIGHTENER

Figs. 1 and 2 of the accompanying illustrations show two views of a new five-roll stock straightener built by the Standard Machinery Co., Providence, R. I. This machine is arranged in two ways. One type is made without a base or clutch and driving pulley. The machine is built in this way when it is

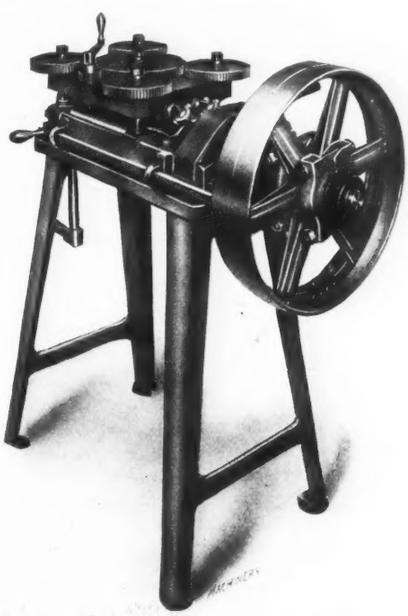


Fig. 1. Standard Five-roll Stock Straightener

to be attached to the bed of a heavy power press for straightening stock previous to the press operations. In place of a driving pulley, either a friction or ratchet feed mechanism is used and this is attached to a slotted disk on the outboard bearing of the press crankshaft, the mechanism acting as a roll feed as well as a straightener.

This machine is also made with a base supported by legs as shown in the illustration. When constructed in this way, a friction clutch and driving pulley are used. The machine is driven through a transmission case located next to the driving pulley. The spur gears in this transmission case are connected to the rolls by universal joints which can be seen in Fig. 1. The main roll, which is the middle roll of the bottom

train, is directly driven by gearing as are its two mates on each side. These rolls are 2¾ inches in diameter and 10 inches long. The upper ones are adjusted by the spur gears and crank shown, which permits raising and lowering the upper head to accommodate different gages of stock.

On the left end of the main roll shaft, there is a ratchet crank and ratchet, as shown in Fig. 2, which may be fed either backward or forward. This ratchet is used to feed the stock into the rolls by hand and in case the stock becomes buckled,

Fig. 2. Another View of the Stock Straightener

it permits turning the rolls in either direction for the purpose of re-straightening the stock. This ratchet is also used for securing better control over perforated material or stock having large holes punched in it. The adjusting gears, as well as the transmission gears, are cut from steel. The rolls are made of tool steel and are hardened and ground. This machine is for the use of manufacturers of sheet-metal parts in connection with power presses or for firms manufacturing cold-rolled sheet steel, sheet copper and sheet brass.

RYERSON-RICH FORGED DRILL

A forged drill for high-speed service is now being manufactured by Joseph T. Ryerson & Son, 16th and Rockwell Sts., Chicago, Ill. This new drill is hammered or forged to shape instead of being milled, in order to refine the metal and retain the continuity of the fiber or grain of the steel. This forged drill, which is illustrated herewith, has the same general shape and cross-section as a milled drill. The cutting lip is of the same form and the clearance is also the same as with the milled type, so that the good cutting qualities of the latter are com-

Ryerson-Rich Forged High-speed Drill

bined with the strength of a twisted drill in this new product. The hammering of the raw stock to shape is said to increase the strength to such a degree that splitting of the web is entirely overcome. This prevention of splitting is said to be due, principally, to the greater strength and homogeneity of the core as a result of the hammering or forging process. This strength at the core also permits very coarse feeds and, consequently, an increase in production.

The following data relating to the performance of this forged drill on different classes of work indicate its durability, cutting qualities and strength. As an illustration of durability, six 13/16-inch drills bored 40,000 holes through structural beams varying from 1 inch to 2⅝ inches in thickness, and the drills were in good condition after doing this work. As an example of fast drilling, a 2¼-inch drill bored three holes through a 40-point carbon steel block 8¾ inches thick, at the rate of seven minutes per hole for two of the holes and six and one-half minutes for the remaining hole. One-hundred-sixty 9/16-inch holes were also drilled in ordinary 3-inch angle-iron in one hour, actual drilling time. No cooling water or lubricant was used and no stops made for re-sharpening, and the drill was in good condition after doing this work. A ¼-inch size drilled 600 holes through a ¾-inch steel bar without re-sharpening and a 15/32-inch size drilled 100 holes through a hard casting without re-sharpening. These drills can be furnished with regular taper shanks or with one size larger, if desired.

BARNES 26-INCH GEARED DRILLING MACHINE

The W. F. & John Barnes Co., 231 Ruby St., Rockford, Ill., has just brought out an upright drilling machine of the geared type having a new feeding mechanism which gives a more complete automatic control of the drilling spindle. The operator has the choice of two automatic stops, one of which can be set to disengage the worm from the worm-gearing, thus permitting the drill spindle to be quickly returned, while the other disengages the miter feed gears, which arrests the feeding movement but leaves the worm and worm-gear in mesh for further hand-feeding in connection with accurate facing and

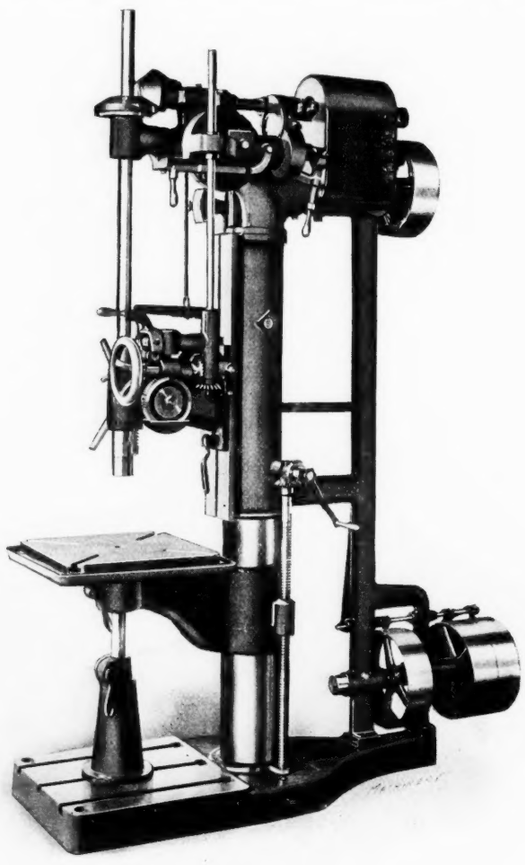


Fig. 1. Barnes 26-inch Geared Drilling Machine

combination tool operations. As far as we know, this feature is new to drilling machine design.

A general view of this machine is shown in Fig. 1 and a detail sectional view of the feeding and automatic trip mechanism in Fig. 2. The feeding movement for the spindle quill is transmitted through miter and worm-gearing in the usual manner. The worm is carried by yoke *A*, fulcrumed at the rear end. This yoke is normally held down by lever *B* which engages a curved seat in the yoke, as shown in the side view. Lever *B* is pivoted at *b*, and when the lower end is swung

toward the front, the yoke *A* is drawn upward by a spring *C*, thus disengaging the worm from the worm-gear. This movement of lever *B* can be effected by hand or by the engagement of a trip *D* with finger *E* attached to a bracket *F* that is clamped to the rack of the spindle quill.

The small lever *G* is used to disengage the miter gears. This lever is connected, as shown in the side view, with a trigger or latch *H* which ordinarily holds the miter gears in mesh. When lever *G* is shifted far enough to disengage catch *I*, the trigger *H* drops, allowing the lower miter gear to fall out of engagement with its mate. This trip can also be operated either by hand or automatically. The automatic trip is set for lever *G* by simply swinging the adjustable finger *E* to the left, as indicated by the dotted lines, in which position it strikes trip *J*, thus disengaging the lever. The position of bracket *F* on the feed rack can be varied as required, and it is permanently attached to the machine by a retaining chain.

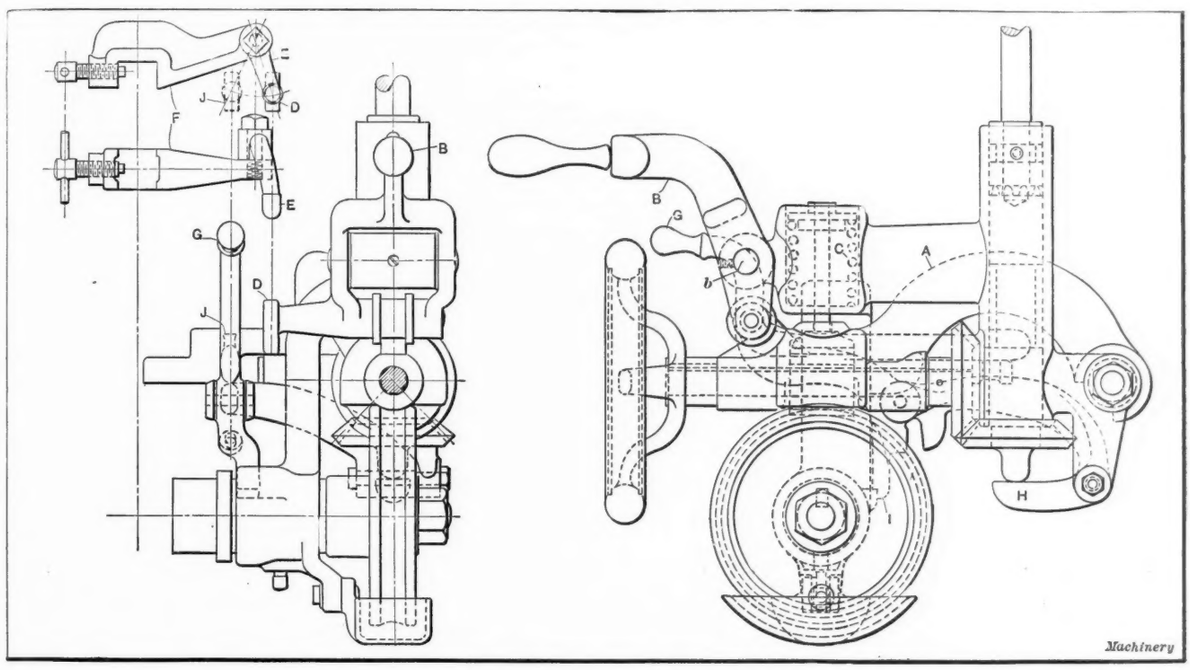
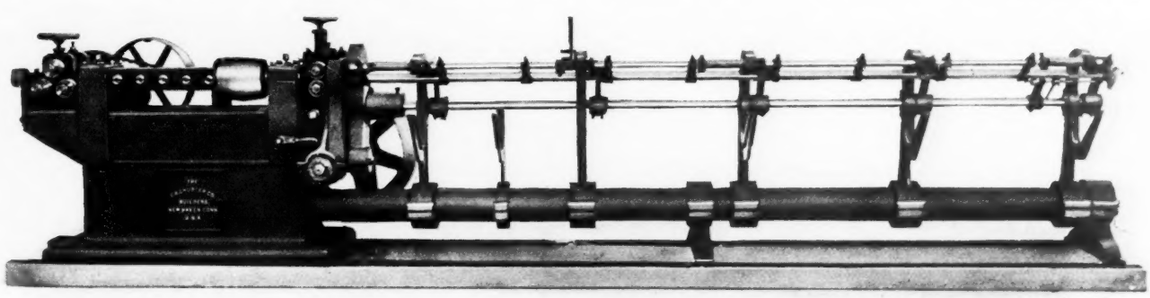


Fig. 2. Feed and Automatic Stop Mechanism for Barnes Drill

In addition to this universal trip mechanism, this machine has a positive feed, a double-splined spindle equipped with roller thrust bearing, a quick-return lever and steel crown gearing. There is a geared speed box of simple but durable construction which gives nine speed changes. These changes are obtained by the use of only nine gears. The speeds vary from 48 to 417 revolutions per minute. All gears run in light lubricating grease. The positive feed mechanism gives eight changes varying from 0.006 to 0.064 inch per revolution of the spindle. The machine will drive a 1½-inch high-speed drill in steel. The principal dimensions are as follows: Maximum distance from spindle to base, 50½ inches; minimum, 20½ inches; maximum distance from spindle to table, 37½ inches; diameter of spindle, 1 11/16 inch; travel of spindle, 11 inches; size of taper hole, No. 4; diameter of column, 7 inches; travel of sliding head, 21 inches; travel of table, 17½ inches; size of table, 18 by 18 inches; weight of machine, 1850 pounds.

SHUSTER AUTOMATIC WIRE STRAIGHTENER AND CUTTER

The automatic wire straightener and cutter shown herewith is a new model built by the F. B. Shuster Co., New Haven, Conn. This machine has a continuous feed, and it is fitted with an arbor and dies of such design that after they are once adjusted for a wire of given size, coil after coil may be fed through without stopping the machine or readjusting the dies. This feature means a considerable saving of time in the course of a day and, consequently, an increase in production. The arbor is longer than usual and it has long bearings as well as end thrust bearings. During the cutting operation, the arbor oscillates somewhat to prevent the dies from injuring the wire while the feed is stationary. Another special feature is a clutch trip which enables the operator to control the cutting mechanism by hand when this is desirable. This clutch trip is operated by the hand lever seen at the front of the machine.



Continuous Feed Automatic Wire Straightener and Cutter built by F. B. Shuster Co.

As the engraving indicates, this machine is the "long-cut" type, which as its name implies, is intended for straightening and cutting long lengths. The machine can also be used for any length less than the maximum. When the machine is in operation, the wire passes from the coil through the rough straightener and the rotary arbor, after which it is fed by the two rolls shown at the right, onto a V-shaped guide bar. The guide bar is equipped with an adjustable gage, which is connected by a wire with a clutch on the cam-shaft. When the

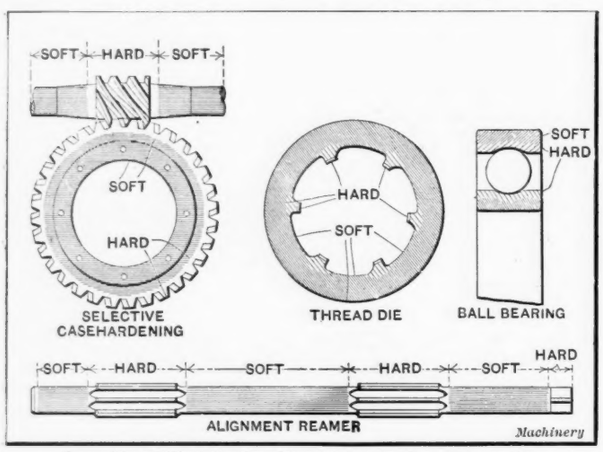
end of the wire strikes this gage, the clutch is thrown and the cutting-off lever swings over, thus severing the wire. From this it will be seen that the length of the wire is determined by the position of the gage. The same movement which operates the cutting-off lever also causes the cut wire to drop from the guide bar into the forked holders shown.

The three-roll rough straightener at the left, through which the wire first passes, is similar to the type used on former models, except that it has double-grooved feed rolls, the same as the front feed rolls and it is connected with the front rolls by a sprocket and chain. These three rolls straighten the material roughly before it enters the rotary arbor, and they are supplied only on the ½-inch machine and larger sizes, the smaller machines not requiring such a device.

This machine may be used for straightening and cutting gold, silver, brass, cold-drawn or rough stock, with equally satisfactory results. The illustration shows a ⅝-inch size designed for handling wire ⅝ inch in diameter and smaller and for cutting lengths up to 12 feet. Other sizes are built on the same general lines, and the length of the machine is made to suit individual requirements.

ENAMELITE FOR SELECTIVE HARDENING

When hardening or casehardening machine parts of various kinds, there are often reasons why some surfaces should be very hard and others soft. One method of hardening steel locally is to cover the part which is to remain soft with a thin metal shield which prevents the covered surface from being suddenly cooled by the direct action of the cooling medium. The Shore Instrument & Mfg. Co., 555-557 W. 22nd St., New



Examples of Work hardened locally by the Use of Enamelite

York, has placed on the market a compound for selective or local hardening which is much more easily applied than a shield and, consequently, more economical. This preparation, which is known as "Enamelite," makes it possible to either harden tool steel or caseharden locally, wherever a hard surface is needed. There are two preparations, one of which is for casehardening and the other for use when hardening tool steel. The first is known as Enamelite, No. 1, and the second as Enamelite, No. 2. Both preparations are in the form of a powder which is mixed with a suitable quantity of hot water before being applied.

When a part is to be casehardened locally, the mixture, which is impervious to the action of carbon, is applied to the surface to be left uncarbonized or soft, either with a brush or by dipping when the latter method is feasible. The Enamelite has no affinity for carbon and it is non-oxidizable and, therefore, prevents the penetration of the carbon vapors or the oxidation of the carbon in tool steel when annealing and also the rapid oxidation of the iron in casehardening boxes, pyrometers, etc. Enamelite is used when it is desired to harden locally such parts as gears, etc. For example, the rims, teeth and bore of the hub of a gear could be hardened without hardening the web which would prevent undue warping and insure a more silent running gear. The selective method of hardening can also be applied to advantage in connection with many other parts, either to prevent serious warping or to save unnecessary work after the hardening process in connection with fitting or grinding.

Enamelite, No. 2 for tool steel is also a powder and is mixed with hot water to form a paste or cement. This is readily applied to the surfaces that are to remain soft, and it has the property of clinging to these surfaces and liberating hydrogen (the greatest known non-conductor) when the heated steel is plunged into water. This causes the steel to retain its heat long enough to escape the chill, with the result that it remains soft where Enamelite has been applied. The fused mixture absorbs water, generates steam and automatically separates from the steel after cooling, thus leaving it as clean as though it had not been in the fire. The accompanying illustration, which is self-explanatory, shows some typical examples of work to which Enamelite is applicable.

NEW MACHINERY AND TOOLS NOTES

Swivel Chuck Jaws: Griggs & Henderson, 212 Water St., Fitchburg, Mass. Chuck jaws having swiveling grips set in the ends, which adjust themselves to either taper or parallel surfaces.

Instrument Tray: H. D. Pomeroy, 812 Dillaye Building, Syracuse, N. Y. Draftsmen's instrument tray supported on double-hinged polished aluminum brackets. The tray or shelf is of wood and is covered with felt. A pocket is provided to hold an ink-bottle securely.

Saw-setting Machine: Rotary File & Machine Co., Brooklyn, N. Y. Band-saw setting machine having a capacity for saws varying from ⅛ to 1½-inch in width. Two saw-teeth are set for each revolution of the pulley or crank and the movements of the machine are automatic. The teeth of old saws which are uneven in height, are set uniformly.

Brazing Outfit: Turner Brass Works, Sycamore, Ill. Portable brazing outfit using either gasoline or kerosene as fuel and adapted for brazing, tempering, annealing, etc. It has two burners which are attached by copper-covered flexible tubing to a ten-gallon seamless steel tank equipped with an air pump and gage. The flame is regulated by needle valves and the outfit will burn full blast for five hours without refilling.

Tool-holder: Precision Machine & Tool Works, 273 Seyburn Ave., Detroit, Mich. Boring-bar and adjustable tool-holder having a split cylindrical block which contains in an offset position a hollow cold-drawn steel bar, in which the cutter is held by means of a draw-bolt. There are two of these bars of ⅞ inch and 1⅛ inch diameter, respectively. The construction of this holder provides vertical or angular adjustment, and the regular toolpost is used for clamping.

Hydraulic Press: Watson-Stillman Co., 192 Fulton St., New York. Hydraulic press especially adapted for forcing the brass bearings or "shells" in or out of locomotive driving boxes. The press is provided with a ¾-inch by 2-inch duplex pump. A safety valve is used in connection with the pump to prevent a dangerous overload. This press is made in two sizes, having capacities of 60 and 100 tons, respectively. It can be operated either by hand or with a belt or motor drive.

Tool-holder: Ernest Stoecklin, Ridgefield Park, N. J. Lathe tool-holder consisting of a cylindrical piece, clamped horizontally in a split block which, in turn, is bolted to the tool-slide. The cylindrical tool-block has six holes of different diameters in which tools of various sizes are inserted. The hole for each tool is split and the tools are clamped by a single bolt which holds the split block to the tool-slide. The tools vary in diameter from ¼ to 1 inch, are 12 inches in length, and have cutters at each end.

Collapsible Tap: Manufacturers Equipment Co., 165 N. Jefferson Ave., Chicago, Ill. Collapsible tap for accurately threading iron, brass and steel and especially adapted for threading close to internal shoulders. There is adjustment for both diameter and depth to be tapped. The tap proper is composed of cylindrically shaped chasers which are in engagement with one another and in rolling contact, thus insuring rigid support. This tap is made in ten sizes varying from 15/32 to 2 1/2 inches, including straight or taper iron pipe sizes from ¼ inch to 2 inches.

Cold Saw: Espen-Lucas Machine Works, Front St. & Girard Ave., Philadelphia, Pa. Cold saw cutting-off machine having a 40-inch blade and capacity for sawing round and square bars up to twelve inches in diameter. This machine is furnished with either a belt or motor drive. The saw carriage has a feed of from ½ inch to 6 inches per minute, obtained through a friction plate and controlled by a lever which is automatically locked. This same lever also controls a quick-return movement for the carriage. Either air-clamps or screw clamps are furnished, depending on requirements. For the rapid handling of stock where multiple cuts are to be made, the machine is equipped with a stock feeding attachment, capable of handling bars 12 inches in diameter and any length up to 20 feet. In practice, as well as in shop tests,

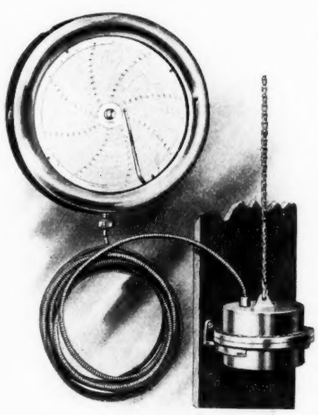
this machine has cut 10-inch square billets of 0.35 carbon steel in 4 minutes, 52 seconds. Bars of the same carbon content, having a 12-inch section, have been cut off in 6 minutes; 9-inch sections in 3 minutes; and 6-inch sections in 1 minute, 27 seconds.

Universal Grinder: Modern Tool Co., Second & State Sts., Erie, Pa. Full universal grinding machine of small size, designed for general tool-room work or the grinding of small parts in manufacturing. The sliding table is controlled in all its movements by a handwheel mounted on a sleeve which carries at its opposite end a clutch. This clutch engages the table driving clutch, when moved outward, at which time the handwheel is motionless, whereas a movement in the opposite direction brings the table under hand-control. The reversing transmission is an improved type of clutch motion which is simple and positive in its action. The cross-feed is so arranged that the minimum or maximum feed may be obtained by a hand lever within convenient reach. There is a minimum feed of 0.0001 inch and a maximum feed of 0.001 inch. Intermediate positions of the feed lever dial indicate 0.0001 inch. This machine has a normal swing of 5 inches, which is increased to 7¾ inches by removing the water guards. The maximum distance between the centers is 16 inches.

* * *

RECORDING LIQUID LEVEL GAGE

A new form of recording liquid level gage has been designed by the Industrial Instrument Co., Foxboro, Mass. to make continuous records on a circular chart of the height of water or other liquids in tanks, reservoirs, dams, tail races, etc. This instrument consists of a recording gage which is connected by a small copper tube with a rubber diaphragm enclosed in a brass case, the lower section of which is perforated for the admission of the liquid. A pressure equivalent to the depth is exerted against the diaphragm, and this pressure is transmitted, as compressed air, through the connecting tube and is recorded in ink on a circular chart which revolves once in twenty-four hours or seven days, as desired. The accompanying illustration shows the compact diaphragm movement which is employed for depths up to 20 feet. The bent arm of the recorder is attached to and supported by a small but substantial shaft which serves as an axis of rotation. The recorder is made moisture- and dust-proof by means of a gasket between the door and body of the case and by cementing the glass in the door, and it may be located at any convenient place. A connecting tube 100 feet long can be used, if necessary, and the equipment is not affected by freezing temperature.



Gage for Recording on Circular Chart Height Variations of Water or other Liquids

* * *

FINISH ON AUTOMOBILE CHASSIS

A feature of the automobile shows that never fails to attract attention is the chassis of cars in various finishes. An approved finish is polished metal throughout. Some manufacturers provide a mirror underneath the chassis to reflect the underside of the frame and mechanism. The mirror makes inspection easy, and heightens the general effect. Other kinds of finish are paint and enamel of colors chosen for general effect and contrast. The polished, painted and enameled chassis can be accepted as legitimate forms in which to present the mechanical features of cars advantageously, but we draw the line at gold leaf finish. A chassis shown at the Grand Central Palace show in January was "completely covered with pure gold leaf." The effect was displeasing to the tastes of good judges of automobile construction, being inharmonious with the subject. Gold leaf has its place on the frames of paintings and the domes of fine public buildings where the color and durability are desirable characteristics, but on a stock chassis—never!

AMERICAN MUSEUM OF SAFETY AWARD OF MEDALS

Three gold medals were presented at the annual exercises of the American Museum of Safety, held in the Engineering Societies Bldg., New York, January 18. The award of medals was as follows: The Travelers Insurance Co.'s medal to the Pennsylvania R. R. Co.; the *Scientific American* medal to the Norton Co., Worcester, Mass.; and the Louis Livingston Seaman medal to Dr. Alvah H. Doty, health officer of the port of New York.

The presentation was made by Dr. F. R. Hutton to the representatives of the Norton Co., the Pennsylvania R. R. Co., and Mr. Doty, these being Messrs. George N. Jeppson, superintendent of the Norton Co.; W. W. Atterbury, vice-president in charge of the operating department, Pennsylvania R. R. Co.; and Dr. John W. Brannan, president of Bellevue and Allied Hospitals, New York, respectively. Mr. Arthur Williams of the New York Edison Co., presided. Dr. Hutton made the presentation speech in a particularly gracious and effective manner. He said in part:

"The first medal has been awarded to the Norton Co., for achievements promoting safety in machinery for grinding processes manufactured in its shops, rapidly revolving emery wheels and the like, all attended with numberless dangers, most of which have been eliminated through the careful study and improved protective devices adopted by the Norton Co. The second medal is awarded to the Pennsylvania R. R., for achievements of safety in its shops, for the diminishing of accidents to its employes at the bench or operatives on the line, and to the traveling public it carries. The Louis Livingston Seaman gold medal has been awarded to Dr. Alvah H. Doty, who for many years has been the watchful Cerberus of the door of the Port of New York, guarding the Nation's health."

Mr. Jeppson responded briefly and referred to the medical inspection system lately instituted by the company, which was described in MACHINERY, January number.

Mr. Atterbury said in part:

"Industrial safety is an important branch in the broad humanitarian scheme that has characterized the policy of the Pennsylvania R. R. for many years in the conservation of human life and energy. The American Museum of Safety is rendering a great public service by directing attention to the enormous waste of human industrial efficiency; in giving to the country at large the results of expert investigation; and in spreading broadcast a knowledge of the methods and means which will overcome a large measure of this waste.

"Our public schools afford possibilities for educational work in impressing upon the children the doctrine of caution in protecting themselves and others against common everyday dangers of street and home. If the necessity of caution is impressed on the child's mind, in his after life it will have become instinctive. We carefully step aside from a snake in the road, and as carefully avoid crossing a field if there happens to be a bull in it. These are common examples of what has become instinctive caution. The necessity to 'Stop, Look and Listen,' and the danger of trespassing, might well form subjects of elemental instruction in our public schools. Already one of our neighbor-states has inaugurated a course of elementary instruction, requiring every teacher or instructor in every public, private or parochial school to devote not less than thirty minutes of each month to the instruction of pupils on fire dangers.

"While through its own efforts much has been done by the Pennsylvania R. R., in reducing the hazard of its passengers, employes and travelers on the highway, it is necessarily dependent upon constituted authority finally to eliminate that greatest source of death and injury—trespassing. In England and on the Continent, the laws are stringent and zealously enforced. In our country we receive but little aid and encouragement in the enforcement of such laws as we have, nor can much be accomplished until proper and uniform laws have been passed and the authorities recognize their responsibility and cooperate with us in our efforts. The Pennsylvania R. R., by the installation of protective devices, decreased the number of serious injuries to employes in its shops by more than 63 per cent from January 1 to November 1 of last year. In the Fall of 1910, experts from one of the large accident insurance companies were employed by the railroad to inspect all of the larger shops, and to make recommendations as to what should be done to increase the safety measures then in force. The result of this campaign was marked by a decrease in serious injuries, per one thousand shop employes, from 8.7 in January to 3.2 in October; the average number of employes was 33,242."

Following Dr. Brannan's tribute to Dr. Doty, lantern slides were exhibited by Dr. W. H. Tolman, director of the American Museum of Safety, showing the grinding wheel guards and safety collars made by the Norton Co., and the safety devices used by the Pennsylvania R. R., for the protection of trainmen and workmen in the shops and elsewhere, etc.

MACHINING LARGE BED ON LUCAS BORING, DRILLING AND MILLING MACHINE

The latest and largest "precision" boring, drilling and milling machine built by the Lucas Machine Tool Co., Cleveland, O., is shown in the accompanying view milling the pad for the speed change gear-box of a bed which is similar to the bed of the machine doing the work. After the milling is done, the bed is already in position for drilling the holes for the bolts which hold the gear-box to the bed. On this size machine, the 18-inch milling cutter shown, and other smaller cutters down to a certain size, are bolted to the internally geared faceplate which is driven by a pinion at the top. When still smaller cutters are used, or if for any reason higher speeds than those given by the faceplate drive are required, the pinion is withdrawn and the sleeve by which the spindle (bar) is driven and through which it slides, is then driven directly by a smaller gear at the left, thus eliminating excessive speed and wear. This change is made by the two levers shown at the left of the operator's shoulder, which interlock, thus making it impossible to engage both drives simultaneously.

The internally geared faceplate can be entirely removed, if it is in the way of smaller work or if for any other reason this would be desirable. In such a case the smaller milling cutters are bolted directly to the sleeve through which the spindle slides, giving a much stronger drive than if driven by the spindle itself. Whether the internally geared faceplate is on or off, it is not necessary to remove the milling cutter in order to use the spindle for other purposes. In the example of work illustrated, the spindle is, of course, used for drilling holes in the end of the bed.

It will be seen that on account of the length of the bed which is being milled, the tail-block and yoke have been removed. The base of the yoke, which is shown between the platen at the left and the auxiliary table support at the right, does not need to be removed, as the yoke can be taken off the base simply by removing four bolts, thus allowing easy and quick preparation for the class of work shown.

* * *

Chemical analysis of lubricants discloses many facts which go to explain the judgment of lubrication experts that most plants spend a good deal more money than is necessary for this item. A report by Arthur D. Little, Inc., chemists and engineers, of Boston, gives some details as to a branded cylinder oil of medium price, which is declared to be a good oil so far as the cylinder stock is concerned, but analysis disclosed that its 6 per cent of fatty oil was not tallow oil as it should have been but degras or wool grease, which is very inferior to tallow oil. Degras is the less expensive, but a cylinder oil compounded with it cannot give first-class service.

BROWN & SHARPE THREAD CHASING ATTACHMENT

The Brown & Sharpe Mfg. Co. has lately designed an attachment for its automatic screw machines for chasing threads of such form that it is not practicable to cut them with a die. This attachment is shown fastened to a No. 0 machine in Figs. 1 and 2.

When the work in the chuck is ready for chasing, the driving spindle is generally operated at a reduced speed, and it is rotated backward. The rear cross-slide is advanced by the cam on the front cam-shaft, which brings the movable part of the attachment up until the one-tooth clutch is engaged. One part *A* of this clutch (see Figs. 1, 2 and 3) is keyed to the shaft on which the helical gear *B* is also held by a key. This gear is driven by a helical pinion *C*, formed in a special cap which replaces the ordinary cap used in holding the chuck in place. This cap is prevented from loosening when driving the attachment, by a brass plug held by a headless set-screw. A plug is threaded into the nose of the cap to prevent the chips from getting into the gear teeth.

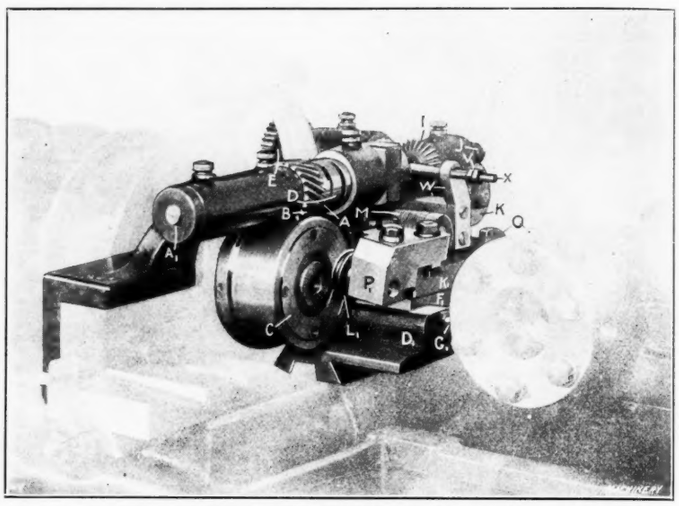
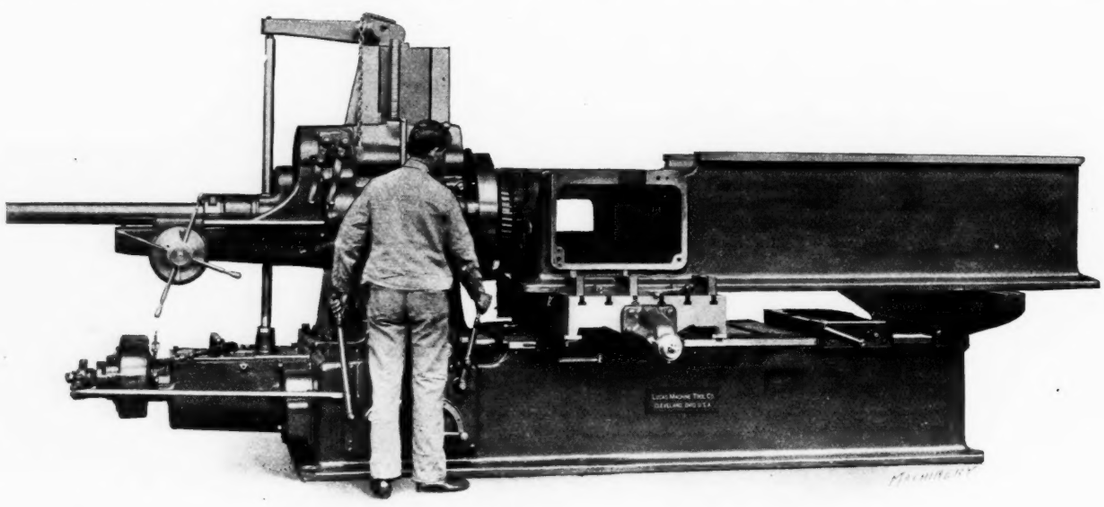


Fig. 1. Front View of Thread Chasing Attachment showing Chaser and Means of Driving from the Main Spindle of the Machine



Milling End of Bed on Lucas Boring, Drilling and Milling Machine

As the two parts *A* and *D* of the one-tooth clutch engage, they drive the spur gear *E* through the bevel gears *F* and *G*, and also the spur gear *H* through the bevel gears *F*, *G* and *I*, and the worm and worm-wheel *J* and *K*. Gear *E* meshes with a smaller gear keyed to the shaft *L* on which the leader *M* is held. This leader is provided with a buttress thread—the best type of thread for this purpose—which acts as a guide for the leader plate *N*, the latter guiding or traversing the top-slide K_1, holding the chaser L_1.

The spur gear H drives a smaller gear O, which is keyed to the shaft P, and rotates the advancing cam Q and the retarding cam R. The advancing cam Q keeps the leader plate N in contact with the leader M when the roll S held in the bellcrank T, is on the largest part of the cam. When this roll drops into the cut-away portion of the cam Q, the roll U on the other arm of the bellcrank is on the top of the lobe on cam R. This action of cam R disconnects leader plate N from leader M.

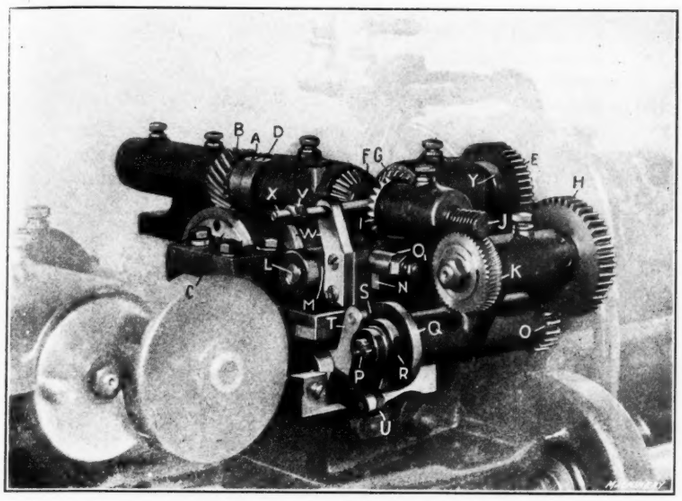


Fig. 2. Rear View of Thread Chasing Attachment showing how the Top-slide and Cams for Operating it are driven; also the Leader for Controlling the Pitch of the Thread

Should spring M_1 fail to return the top-slide to its backward position, the adjusting lock-nuts V can be set so that when the arm W, held on the top traversing slide, comes in contact with them it pulls out the rod X which disconnects the one-tooth clutch Y. Part of this clutch Y is made integral with the gear E, which is bronze-bushed, while the other part is held on the shaft Y_1 (Fig. 3) and is provided with a pin driven through it and the shaft, and fitting in an elongated slot in the sleeve holding gear E. This allows for a lateral movement of the pivoted part of clutch Y so that gear E is disconnected from the driving mechanism. The one-tooth clutch Y is kept in contact by means of a spiral spring, which is more clearly shown in the plan view, Fig. 3.

Construction of the Thread Chasing Attachment

Referring to Fig. 4 where the piece to be made is shown at A, it will be seen that the thread is ⅛ inch pitch and is of special form. The means by which this thread is chased will be better understood by referring to the elevation and plan views of the attachment shown in Fig. 3. Here the method of driving is more clearly shown. The helical pinion C, which is formed on the special cap, is provided with 22 teeth, having a tooth angle of 63 degrees, 26 minutes, while the helical gear B, held on the main driving shaft of the attachment, is provided with 22 teeth, and has a tooth angle of 26 degrees, 34 minutes. By having the tooth angles thus arranged, it is possible to get the same number of teeth in both gear and pinion; hence the main driving shaft of the attachment is rotated at the same speed as the spindle of the machine. If the gear and pinion were provided with teeth cut at an angle of 45 degrees, it would be necessary to have them of the same diameter.

As the main driving shaft of the attachment A_1, Fig. 3, rotates at the same speed as the spindle of the machine, it is evident that the gear E will also rotate at the same speed, because the bevel gears F and G have the same number of teeth. As gear E has 42 teeth and meshes with gear E_1, which has 21 teeth, it follows that the leader M must rotate at twice the speed at which the spindle of the machine is rotating. This makes it necessary for the leader to have a thread of 1/16 inch pitch instead of 1/8 inch, which is that required on the work.

The machine is rotated backward for chasing at 445 R.P.M., and as four threads or convolutions are required on the piece, it is evident that the leader plate N should be kept in contact with the leader M for a sufficient space of time to complete the thread. This is accomplished by arranging the ratios of the worm J and worm-wheel K, as well as the gears H and O, to suit the time required for the top-slide to traverse. Worm J rotates at 445 R.P.M., and as it is provided with a quadruple thread it moves the worm-wheel K through a space of four teeth for every revolution of the spindle. As worm-wheel K has 48 teeth, it means that the worm-wheel, relative to the spindle, rotates at about 37 R.P.M. Now as gear H is provided with 40 teeth and gear O with 20 teeth, the cam-shaft P is rotated at 74 R.P.M. It now is a simple calculation to obtain from these data the required amount of "dwell" on the cam Q.

By referring to Fig. 3, it can be seen that this attachment consists of two brackets B_1 and C_1. The bracket B_1 is fastened to the frame of the machine, while the bracket C_1 carrying the operating mechanism is cast integral with a base which replaces the ordinary cross-slide. This base carries a plate D_1,

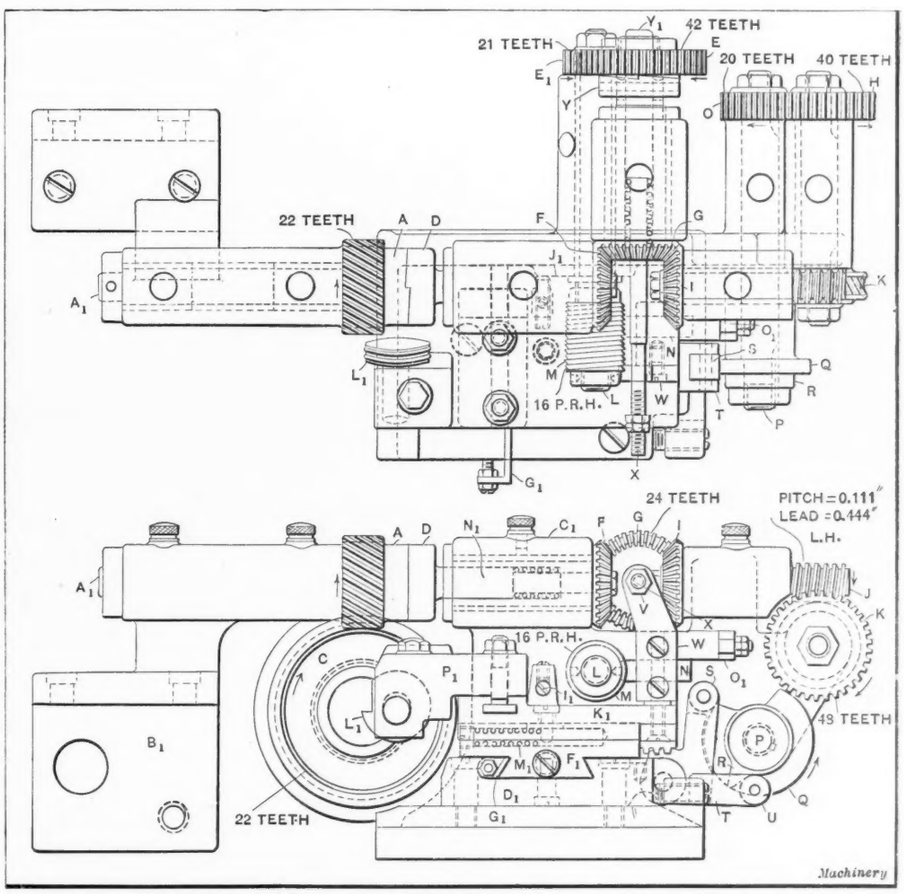


Fig. 3. Elevation and Plan Views of Thread Chasing Attachment showing its Construction

having a dovetailed groove cut parallel with the axis of the machine spindle. Fitting in this groove is a slide F_1, furnished with a taper gib G_1 to provide for wear. This slide is returned to its "back" position, when, by means of a spiral spring, the leader and leader plate are disengaged, the slide being stopped by the set-screw I_1 which comes in contact with the boss J_1. This allows the slide to start from the same point for every traverse of the chaser across the work so that work and chaser are always in step.

The chaser L_1 which is held to the block P_1 on top-slide K_1, is brought up in contact with the work by the cam Q, and is operated by the bellcrank T, the latter being provided with a segment gear that meshes with a short rack attached to the top-slide. The chaser L_1 is cut down 1/8 inch below center, similarly to an ordinary circular tool, and is held at the required angle with the work so that it will not drag. The rolls S and U in the bellcrank T are kept in contact with the cams

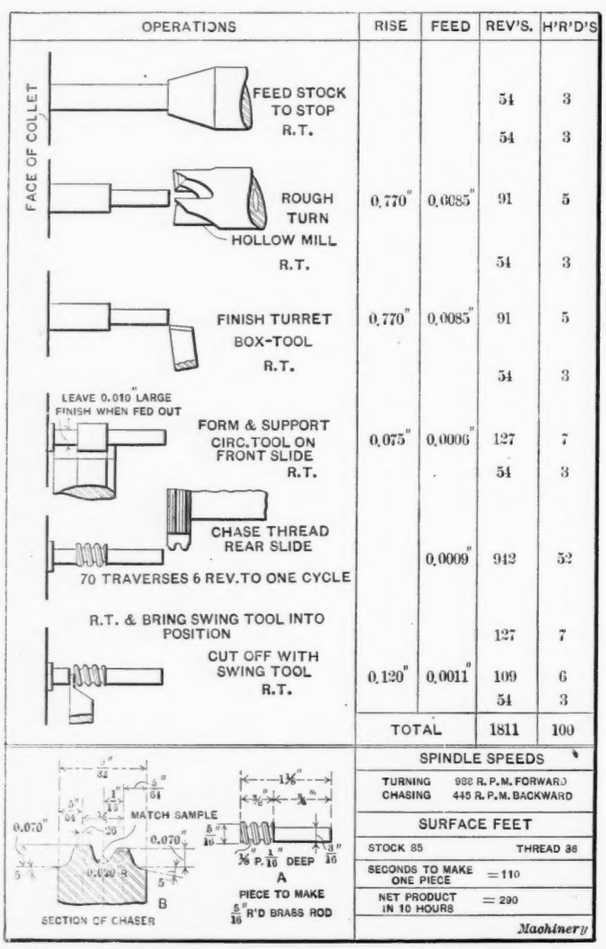


Fig. 4. Chart showing Order of Operations, Work and Other Data pertaining to the Production of a Piece having a Chased Thread

R and Q by means of a spring M_1, as shown. The plate D_1 is provided with a slight adjustment for cutting straight threads, and the leader plate N is adjusted by means of the device O_1.

All shafts of this attachment run in phosphor-bronze bearings provided with oil grooves. The shaft N_1, to which the bevel gear F is held, is provided with a coil spring so as to facilitate the free locking action of the one-tooth clutch. To adapt this thread chasing attachment to other work it is only necessary to change the gears E, E_1, H and O, leader M and leader plate N. A still greater range can also be obtained by changing the worm J and worm-wheel K, as well as cams Q and R. These latter parts, however, can be used for a considerable range of pitches.

Order of Operations

The order of operations followed in completing the part to be chased is presented in Fig. 4. In operation, the stock is first fed out to the stop, and then the turret is revolved, bringing in the roughing hollow mill which roughs down the end of the work. The turret is again revolved and the finishing box-tool is brought into operation. After this, the turret is revolved and the front cross-slide advances carrying the circular forming tool. A support held in the turret is then brought in contact with the work to steady it while roughing down the diameter at the rear of the shoulder.

Following the turning operation, the rear cross-slide advances connecting the two parts A and D of the one-tooth clutch. This starts the operation of the attachment, when the top-slide K_1, Fig. 3, is traversed back and forth. This slide is carried forward by the leader and leader plate, then released by the cams Q and R, and returned by the spring until the set-screw I_1 touches the stop, when the cam Q again brings the leader and leader plate into contact, and the chasing continues. Seventy traverses of the chaser across the work are necessary to complete the thread, requiring six revolutions of the spindle to one cycle, that is, one back and forward movement of the top-slide. While the top-slide is traversing back and forth in this manner, the cam on the front cam-shaft is feeding the chaser into the work. As this cam is provided with a constant rise, it is evident that the tool is being fed in further all the time, so that at first it produces a tapered thread on the work, but as the slide approaches its full travel, the thread is "straightened"—made of equal depth from one end to the other. Before the chaser is brought into operation the spindle is reversed from 988 to 445 R.P.M., and from a forward to a backward direction.

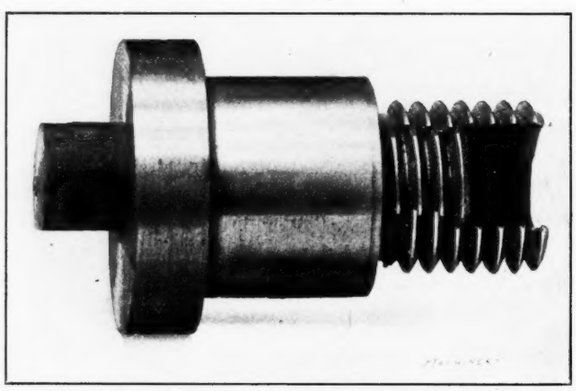
As it is impossible to hold a circular tool on the rear cross-slide for cutting off the work, a cut-off tool made from rectangular stock is held in a right-hand swing tool, which is retained in the turret and operated by a rising block on the front cross-slide. Before the cut-off operation takes place, the attachment is disconnected by the cross-slide dropping back. After the piece is cut off the turret is revolved and the cycle of operations repeated. An enlarged section showing the shape of the chaser is illustrated at B in Fig. 4.

* * *

UNUSUAL DEFECT RESULTING FROM A PIPED INGOT

The accompanying illustration shows a shouldered bearing screw made by the Cleveland Planer Works, Cleveland, Ohio, which after completion was found to have a curious defect. Part of the screw near the center was found entirely detached, and so loose that it was easily driven endwise, as shown in the illustration, about one-half inch.

The explanation is that the ingot from which the bar was



Unusual Defect Resulting from a Piped Ingot

rolled, was piped and when "plugged" with molten metal, the plug did not properly weld with the exterior. In rolling, the filling plug and the outer part extended together, but completely separated leaving them in the state found when the piece was machined. The pipe extended 14 inches in the bar and was not discovered until eight pieces had been finished and cut off. While defects of this class are often found in rolled stock, it is seldom that a complete separation of the parts is discovered.

* * *

The world's production of aluminum has risen from 12,500 tons in 1905 to 37,000 tons in 1910.

NEW YORK MONTHLY MEETING OF THE A. S. M. E.

The members of the American Society of Mechanical Engineers, New York, held their first meeting of the year on January 9 to consider the work of the society for the current year. Prof. Rautenstrauch of Columbia University opened the meeting with a few general remarks in which he stated that 10 per cent of the success of the work of a society of this kind is due to the proper planning, and 90 per cent, to the proper carrying out of the work. He introduced the new president of the society, Dr. Humphreys. The substance of Dr. Humphreys' remarks was that the fundamental requisite for success in the work is harmony. He stated that the mechanical engineering field includes thirty-five or forty branches, and it is necessary to determine in advance how much can be done and done thoroughly. He expressed the hope that the society would be able to enlarge its membership along the right lines, and then briefly took up the financial details.

Dr. Lucke of the meetings committee was the next speaker, and he designated the work of the committee as consisting of the soliciting and judging of the manuscripts presented, and the directing of the meetings. It was his opinion that the transactions of the society's meetings should reflect upon their practice. As this practice varies in its scope, he considered that the five members of this committee were inadequate to judge intelligently of the merits of the manuscripts received. The commitee concurs with this idea, and has appointed several sub-committees, the members of which are specialists in their particular fields. These committees serve without recompense, and it is believed that the judging of manuscripts will be more intelligently, as well as more easily, done in the future. The members of these various committees will be shortly announced.

Mr. F. A. Waldron of the New York local committee was next heard from. For the local committee he stated that all suggestions in regard to the work of the committee would be very welcome and his remarks were along the lines of the work of the local committee. Particularly is the committee anxious to instil enthusiasm in the 1100 New York members. For various reasons the Boston meetings seem to be better attended than the New York meetings, although the membership is smaller in Boston. This is due partly to the stringent calls upon the New York members in their business and kindred reasons. The question of raising funds for the entertainment of out-of-town members seems to him to be a difficult one. Various plans for accomplishing this work were considered.

A brief discussion of the raising of funds for special entertainment of non-resident members then followed, which was participated in by Messrs. Gilbreth, Pomeroy, Van Winkle, Meier, Cobleigh, and others. The consensus of opinion seemed to be that the difficulty was due to the fact that the dues of the American Society of Mechanical Engineers are much lower than other similar organizations, and it was generally conceded that the subscription method is not the proper way of raising these funds. Further statements in regard to finances came from Mr. R. M. Dixon. In the absence of Mr. G. J. Foran of the membership committee, Mr. Hosea Webster spoke of the work of the membership committee. Their main problem is to advise members as to the necessary qualifications that prospective members must have, to furnish application blanks that convey the necessary information, and to advise indorsees of applicants what their responsibilities are. The addition of associate members from the allied trades is perhaps desirable from the numerical standpoint, but it is the aim of the membership committee to keep the society an engineering society rather than a business society. Mr. F. R. Low made a few remarks for the publication committee. The work of this committee embraces the *Journal* and the year book as well as the issuing of the various papers. Its policy is to give the technical press latitude in regard to the publication of reports, abstracts and papers. The *Journal* is now regularly reviewing 220 foreign publications in nine or ten languages, and it has been fortunate in securing for this work an efficient engineer who is also a linguist of some note. The *Journal* is self-supporting through its advertising matter and is offered to the public practically at cost. It is expected that the earnings of the *Journal* will increase in the future and it is the desire of this committee to give the members a better journal in proportion to the increased earnings.

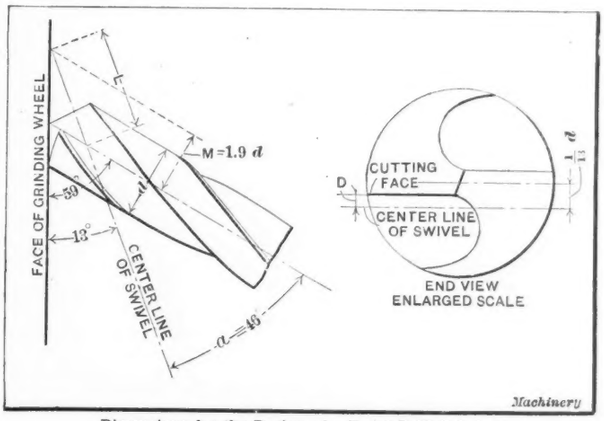
Dr. Leonard Waldo was next heard from in regard to the society's library. Dr. Waldo talked in an entertaining way, dealing particularly with the research work that is carried on so extensively in Germany. He drew the attention of the members to the fact that complete collections of the patents of the leading foreign countries are now available in the New York Public Library. Mr. Edward Van Winkle of the house committee then gave a brief talk on the business of this committee, after which general remarks were offered by several members, and the meeting adjourned.

* * *

DESIGN OF TWIST DRILL GRINDER

In the September, 1911, number of MACHINERY, L. K. S. submitted three questions relating to the design of twist drill grinders. In the November, 1911, number of the German publication *Werkstattstechnik* an article appears which gives some information on this subject. Referring to the accompanying illustration L. K. S. asks, "What should be the angle a from the center line of the swivel of the drill grinder to the center line of the drill?" According to the source referred to, the angle between the center line of the swivel and the face of the grinding wheel should be about 13 degrees, as shown, which with an angle of the cutting lip of the drill of 59 degrees, gives angle $a = 59 - 13 = 46$ degrees.

The second question submitted was as follows: "What should be the distance L from the point where the center line



Dimensions for the Design of a Twist Drill Grinder

of the swivel intersects the face of the grinding wheel to the point where the same center line intersects the center line of the drill?" This dimension should be a function of the diameter d of the drill and should be practically $2.64d$. This dimension is calculated from the dimension $M = 1.9d$, as shown in the illustration, which is the distance between the point where the center line of the swivel intersects the face of the grinding wheel to the axis of the drill.

The third question asked is, "What should be the distance D from the cutting face of the drill to the center line of the swivel for all sizes of drills?" As the location of the cutting face of the drill may vary somewhat in drills of different makes, the dimension determining the location of the center line of the swivel is not given with reference to the cutting face, but with reference to the axis of the drill, the dimension being $1/13d$, as shown in the illustration.

* * *

The German electrical industry is in a flourishing state, and the Siemens & Halske and Siemens-Schuckert Werke, especially, have had an exceptionally good business during the last financial year. The business of Siemens & Halske for the last seven years has shown a tendency to steadily improve. In 1905 a dividend of nine per cent was declared, the following year ten per cent, during the two following years, eleven per cent, and for the last three years, twelve per cent. The Siemens-Schuckert Werke pay a dividend of ten per cent on their stock regularly.

THE NATIONAL AUTOMOBILE SHOW

The National Automobile Show, held under the auspices of the National Association of Automobile Manufacturers, at the Grand Central Palace, New York, January 10-17, offered a great deal of interest to those who are concerned in the mechanical innovations in, and the commercial development of, the automobile trade. There were more than seventy exhibitors of automobiles, and nearly that number of exhibitors of accessories. The exhibition was distributed over three floors of the exhibition building, which, by the way, is entirely new and offers unusual advantages for the proper setting of a show of this kind. The first floor was devoted almost exclusively to passenger automobiles, many of which, however, were of a type designed especially for business uses. The second floor was devoted to trucks and commercial vehicles in general, delivery wagons, etc. It is apparent that a great deal of attention is now being given by automobile builders to the commercial vehicle business. Large high-powered trucks with a loading capacity of from three to four tons and an available power of from 30 to 40 horsepower were everywhere in evidence, but many firms also exhibited smaller trucks and delivery wagons for light loads. The use to which the automobile truck is being put is now extremely diversified. Large covered moving vans, coal delivery wagons, heavy brewery trucks, and wagons intended for general trucking purposes for manufacturing establishments, were exhibited side by side with dozens of different models of department store delivery wagons, newspaper delivery trucks, etc. A few models of ambulances were also exhibited. It would seem, to the casual observer at least, as if there is hardly a field where horse-drawn vehicles are used in which the automobile is not gaining ground.

Four or five of the models were provided with friction drive and a transmission chain from the friction wheel to the rear axle carrying the differential. The majority of the trucks exhibited, however, had the common bevel gear drive with double chain drive from the jack-shaft to the rear wheels which are mounted on a dead axle. The chain guard was not in evidence. The worm drive was also conspicuous by its absence, and it would appear that commercial vehicle builders have not taken kindly to this type of drive. In general, there were few radically new mechanical features, but the improvements are rather along the lines of minor changes in previous designs. Innovations in engine construction were displayed in two cars having three-cylinder, two-stroke-cycle air-cooled engines. With these cylinders connected to cranks set 120 degrees apart, the two-stroke-cycle engine develops the same evenness of turning movement as the six-cylinder four-stroke-cycle type.

It is apparent that the tire question is receiving considerable attention, and a great many different types of tires claiming special advantages as regards resilience and wearing qualities were exhibited both in place on the automobiles and in the separate accessories exhibitions, which occupied the third floor of the building. The majority of the cars exhibited were, of course, of the gasoline engine type, but there were five electric passenger cars and two electric commercial vehicles on exhibition. Electric delivery cars have a special field of service which they fill more efficiently than the gas engine car. Where the service required is a comparatively short haul, say twenty-five miles in a day, but involving a large number of starts and stops, the electric car is at advantage. Its simplicity and ease of operation relieve the driver from all concern, for the operation of the car leaves him free to concentrate his mind on his delivery work.

As regards the arrangement of the exhibition, credit should be given to the management for providing wide aisles and ample space for the crowds which are always sure to attend shows of this kind. Comparatively few decorations—so often used to excess in show buildings—were in evidence, and this tended to give the exhibition a still more dignified and pleasing appearance, particularly as the new Grand Central Palace, where it was held, is in itself a building of such attractive architectural appearance that additional decoration is hardly necessary.

THE SHAPER DESIGN—A REPLY

We fully agree with the writer of the article on page 403 of January MACHINERY, engineering edition, that an extended argument between us would be of little avail, and also when he says, "The question of friction is one that can only be determined by tests," although we think "best" would have been a better word to use than "only."

We do not consider that his article was merely "a study in kinematics" as will be patent to any one who will read the first article. We are not willing to take tests made on the same machine changed to suit the maker. We do not question Mr. H. P. Fairfield's honesty, nor do we doubt the tests shown as advertised; we are surprised that they showed so well. It would be interesting to know if the friction of the bull-gear on the column was present, or if the bull-gear was running on that short hub bearing shown in our dissected view. The only tests we would consider conclusive would be with the "Queen City" against the two-piece crank type. Will our competitor put his machine up against ours on fair competitive tests? Will he do this at some intermediate point between factories? We suggest the Case School of Applied Science, Cleveland, Ohio, as a place where we could both have a "clear field and no favor test." Let them understand the discussion and make the tests to satisfy all parties concerned. We will agree to almost any terms.

We understand the size machine in question was a 24-inch, and we are very willing to use our 24-inch as against theirs. Our competitor says, or intimates, that there is too much overhang or some other defect in design that allows spring or cramping, and if this cramping does exist in our shaper, it is self-evident that it will increase as the duty becomes heavier, so we lay ourselves open by challenging them to a series of power efficiency tests, especially on heavy-duty cuts.

We suggest that the loser pay all expenses of the tests, and the greatest possible publicity be given to them, no matter who wins. While the features of accuracy, handiness, durability, etc., also come into the question of machine tool supremacy, we believe the power efficiency test is the most important.

We have always claimed power efficiency for "Queen City" shapers, and would consider ourselves very dishonest if we were not ready to defend this claim against all comers. Neither would we accept as conclusive any tests that were made between our competitor's machine and any other as showing superiority over the "Queen City." We are not from Missouri, but we like to be "shown" just the same.

Cincinnati, Ohio. QUEEN CITY MACHINE TOOL CO.

* * *

Hardly is a very high building erected in New York before another is projected to exceed its height. The highest structure now in process of construction is the Woolworth Building on Broadway, between Park and Barclay streets. The total height of this fifty-five story structure is about 750 feet. Plans have been made for the Equitable Life Assurance Society for a still higher structure to be erected on the site of the building burned January 9. The proposed building was designed to occupy the block bounded by Broadway, Nassau, Pine and Cedar streets, measuring about 489 by 168 feet. The plans called for a main structure thirty-four stories, surmounted by a tower of twenty-eight stories. The total height of the building and tower was 909 feet and the top of the flag-pole was to be carried to a greater height than the Eiffel Tower in Paris.

* * *

The aeroplane industry is apparently booming in France. During 1911, 550 aeroplanes were built in the country. A great many of these were for the French army which, it is estimated, at the end of 1912 will have a corps of over 200 aeroplanes. In Germany, also, the interest in aeronautics is very great. An international aviation and aero exhibition will be held in Berlin, from April 3 to 14, 1912, and will include aeroplanes and dirigible balloons of all kinds, together with motors, propellers, materials, and all kinds of equipment. For information in regard to this exhibition address the Verein deutscher Motorfahrzeug-Industrieller, Potsdamerstr. 121 h, Berlin, W. 35.

FIXTURE FOR MILLING SPIRAL CAMS

By G. W. A.

The barrel cam shown in Fig. 1 was at one time considered a difficult proposition to make, for the reason that we only required a few of these cams, which would not warrant the purchase of a special machine. To overcome the difficult

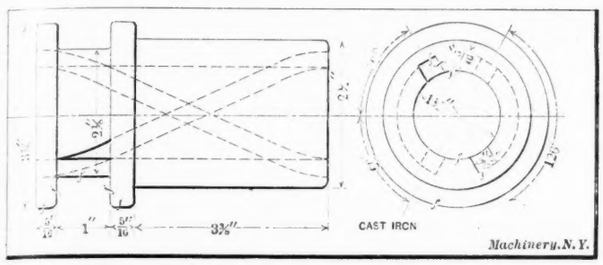


Fig. 1. Barrel Cam with Two Internal Spiral Grooves

proposition of cutting the grooves in this cam, we devised the fixture shown in Fig. 2. This fixture was made to be used on the drill press. The shank *A* was made a good fit in the socket of the drill press and the fixture *B* was bolted to the table by screws passing through the holes *C* in its base.

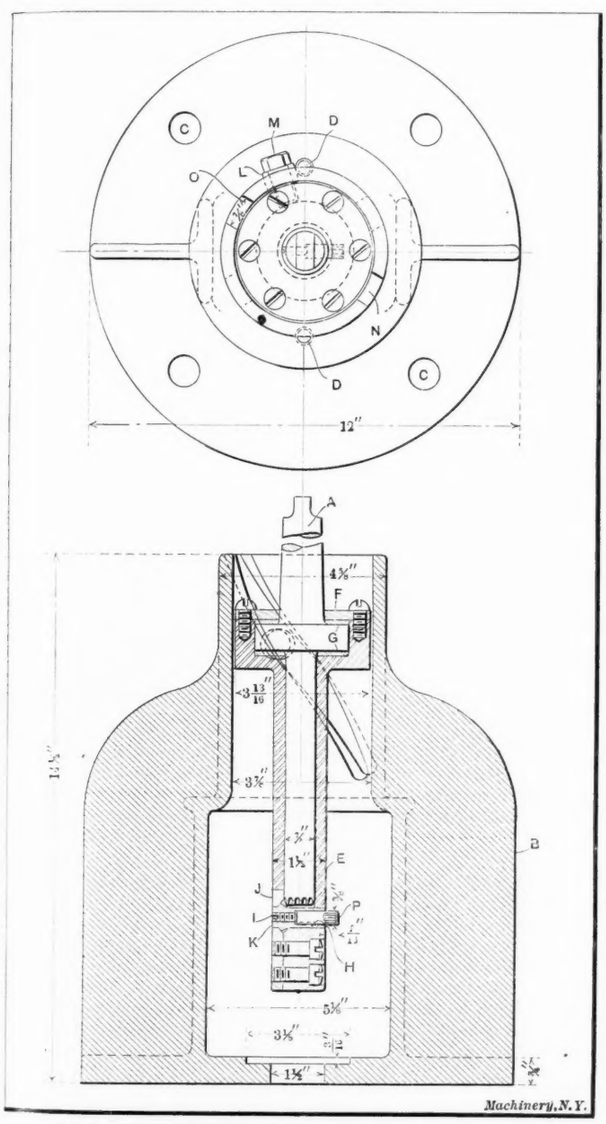


Fig. 2. The Fixture used in Cutting the Spiral Grooves in the Barrel Cam, Fig. 1

This fixture as is clearly shown is ribbed, and the sides of the lower section of the casting, instead of being circular are parallel with each other. A circular cap is formed on the top of these parallel sides, in which two holes *D* are tapped for holding the clamping bolts used in holding a clamping strip not shown. This clamping strip holds the casting down firmly on the base of the fixture. A recess the same diameter as the base of the casting Fig. 1, is cut in the fixture to locate the casting in the correct relation to the spindle The spindle *E* is made 1½ inch in diameter and fits in the hole in the casting, in which the grooves are to be milled. It is fastened to the shank or driver *A* by a cap *F*, which is held down with six button-head screws. Two fiber washers *G* are placed one beneath the cap *F* and one beneath the shoulder on the shank *A* to decrease the friction.

The shank *A* has a bevel gear cut on its lower end which meshes in a corresponding bevel gear held in the spindle *E*. The bevel gear which is held in the spindle *E*, also forms the holder for the end mill *P* used in cutting the spiral grooves. This end mill is kept from rotating by a small key-pin *H* which fits in a groove cut in the shank, and is adjusted outwardly by the headless set-screw *I*. The block *J* acts as a seat for the end mill holder *K*, and is held to the spindle *E* by two fillister-head screws as shown. This cap facilitates the insertion of the mill-holder and forms a seat or bearing for the rear end of it. A roll *L* is fastened to the top part of the sleeve *E* by a shouldered screw *M*, which is made so that the roll is free to rotate. Master grooves *N* and *O* are cut in the cylindrical part of the casting *B* in which this roll is guided while the mill is cutting the groove in the cam.

The manner in which this fixture is operated is as follows: The shank *A* is inserted in the socket of the drill press and the casting *B* clamped to the table; then the casting Fig. 1 is inserted in the fixture and held down by a clamping strip which, in turn, is held by screws inserted in the holes *D*. The spindle of the drill press is then elevated and the roll placed in the grooves *N*. Then the spindle is brought down slowly while the end mill cuts the groove in the cam. After one groove has been cut the spindle is raised again and the roll brought around and placed in the groove *O* and the same operation continued. These grooves, *N* and *O*, as can be seen, travel about three-quarters of the way around the periphery of the upper part of the fixture.

It may be interesting to know that the cam grooves are completed in this fixture, and that it takes exactly fourteen minutes to complete one cam, including the time required to place and clamp it in the fixture. Previous to making this fixture, a milling machine was used for doing the same job and it required eight hours to complete one cam, so it can easily be seen that this fixture was a decided advantage over the previous method.

* * *

Plate-girders of record size have been placed in a crossing of the Boston & Albany R.R. over the New York, New Haven & Hartford R.R. at South Worcester, Mass. They form part of the extensive track-elevation work of the Boston & Albany, at Worcester, which has been in progress during the past year. The crossing is four-track, and comprises five lines of plate-girders in two spans over the New Haven tracks and a truss span over Southbridge Street. The longer of the two girder spans is 122½ feet outside to outside; its girders are 10½ feet deep and each weighs 170 tons. Longer plate-girders have been built in the past, but none of a weight approximating those of the present girders. An unusual feature of the detail construction of the girders is that rivets of 1⅛ inch diameter are employed.—*Engineering News.*

* * *

A large Curtis vertical steam turbine for a rated capacity of 20,000 kilowatt or about 27,000 horsepower, was recently placed in service at the Waterside Station of the New York Edison Co. This turbine has the distinction of being the largest in the world, and would be sufficient to supply all the electric current for a city of about 250,000 population. The turbine is 35 feet, 7 inches high and approximately 17 feet in diameter, covering a floor space of nearly 300 square feet. Its total weight is 420 tons. Two more units of the same type are to be installed at the station. The compactness of these large steam turbines is remarkable. These three 20,000 kilowatt units will occupy no more space than was formerly taken up by four 3500 kilowatt engine-driven units.

PERSONALS

J. W. Higgins has been appointed general manager of the Missouri Pacific-Iron Mountain R. R., to succeed A. W. Sullivan, resigned.

Ellsworth Haring, representing Hermann Boker & Co., New York, left January 13 for a ninety days' stay in Cuba, to look after his uncle's estate.

A. Metivier, a partner in the firm of E. Isbuque & Cie., Antwerp, Belgium, machine tool dealers, will visit the United States early in February.

Fred W. Belcher, for several years with the Knox Automobile Co., Springfield, Mass., has taken the position of superintendent for the Grant Automobile Co., Orange, Mass.

S. Sakuragi, of the South Manchuria Railway Co., Manchuria, China, who for two years has been in the United States studying railway conditions, sailed for China, January 24.

Walter A. Sanders has resigned as superintendent of the Grant Automobile Co., Orange, Mass., to take a position in the engineering department of the General Electric Co., at Lynn, Mass.

Walter Knapp has left the employ of the Niles-Bement-Pond Co.'s engineering department at Plainfield, N. J., to take the position of assistant superintendent of shops, League Island Navy Yard, Philadelphia.

George C. Lasares, draftsman for the past two years with the Parker Transmission Appliance Co., Springfield, Mass., has taken a position with the Bosch Magneto Co., of the same city as purchasing inspector.

D. DeVries, engineer with R. S. Stokvis & Zonen Ltd., Rotterdam, Holland, and author of the works "The Calculation of Change Wheels," and "Milling Machines and Milling Practice," will sail for America in February.

George E. Hallenbeck, for twelve years superintendent of Baker Bros., Toledo, Ohio, manufacturers of high-duty drilling machines, tapping machines, etc., was taken into the firm January 1. The firm name will not be changed.

Francis W. Frost, formerly secretary and treasurer of the *Engineering News* Publishing Co., has been elected to the office of vice-president and treasurer of Suffern & Co., importers and exporters, New York.

J. E. Bellows, representing Cadbury Bros., Birmingham, Eng., sailed for England January 22 following a two months' sojourn in the United States, where he has been studying scientific management of manufacturing plants.

Albert A. Gordon, Jr., has been appointed superintendent of the Crompton-Knowles Loom Works, Worcester, Mass., succeeding William Wattie, resigned. Mr. Gordon is a graduate of the Worcester Polytechnic Institute, class of 1886.

Charles M. Lyle, for several years with Manning, Maxwell & Moore, Inc., in charge of their Southwestern territory, with headquarters in St. Louis, Mo., has resigned to become manager of the Niles-Bement-Pond Co.'s St. Louis office at 516 N. 3rd St.

Monks & Johnson, architects and engineers, 7 Water St., Boston, have associated themselves with Henry F. Keyes, architect, 161 Devonshire St., Boston, for the preparation of plans and specifications for certain large industrial developments.

Clarence Harter, for several years draftsman for the Remington Arms & Ammunition Co., at the Ilion plant, has been promoted to the position of chief draftsman in the company's cartridge works at Bridgeport, Conn., the promotion taking effect January 1.

D. W. Patten, who for several years was salesman for Schuchardt & Schütte, New York, and for the past year salesman with Marshall & Huschart Machinery Co., is now connected with the Windsor Machine Co., Windsor, Vt., selling Gridley "automatics" in Ohio.

Edgar Bloxham, a well-known machine tool dealer of Paris, France, expects to visit the United States early in February and will make his headquarters with A. G. Thompson, 587 West End Ave., New York City, where he may be addressed by any manufacturers who desire to get in touch with him.

Mahlow E. First has been appointed mechanical engineer of the Indiana Harbor plant of the American Steel Foundries, succeeding B. H. Reddy, resigned. Mr. First was formerly with the Morgan Eng. Co., Worcester, Mass., and later with the Pawling & Harnischfeger Co., Milwaukee, Wis., before going to the Indiana Harbor plant as assistant to Mr. Reddy.

Harry G. Stoddard has become associated with the Wyman & Gordon Co., Worcester, Mass., manufacturers of drop forgings, in the capacity of vice-president and general sales manager. Mr. Stoddard was formerly manager of the Washburn & Moen branch of the American Steel & Wire Co., of Worcester, and for the past seven years was president of the Trenton Iron Co., Trenton, N. J.

William Wattie, who resigned his position as superintendent of the Crompton-Knowles Loom Works, Worcester, Mass., in January, after twenty-two years as superintendent, and ten years as foreman of the shop, was given a case of one hundred pieces of silver by the employes of the factory, and a three-piece silver tea service by Messrs. Henry F. and George F. Hutchins of the company. Mr. Wattie is giving up active work, and intends to sail February 8, for a three months' trip abroad.

Col. G. N. Whistler and Major J. E. Bloom, U. S. A., retired, have joined the Institute of Experts, 50 Church St., as technical experts in their respective specialties, explosives, ordnance and supplies. Brig. Gen. T. A. Bingham, U. S. A., retired, at present the chief engineer of the department of bridges of New York City, has consented to act as consulting engineer, when his other duties permit, in subdivisions pertaining to cement, constructions, drainage, terminals and bridges.

F. A. Haughton, formerly general superintendent of the Taylor Iron & Steel Co., has been appointed works manager of the Remington Arms & Ammunition Co.'s gun plant at Ilion, N. Y. Mr. Haughton will be in charge of the manufacturing operations at Ilion and will report direct to Mr. Tyler, the general manager of works who has general charge over the works of the Remington Arms & Ammunition Co.'s gun plant at Ilion and the ammunition plant at Bridgeport, Conn., commonly known as the Union Metallic Cartridge Co. His appointment took effect January 15, and it relieves Mr. Tyler of many of the details of chief management. Mr. Haughton has had several important positions, among which was the superintendency of the American Locomotive Co.'s automobile plant at Providence, R. I.

* * *

OBITUARIES

Almon P. Wint, secretary of Dienelt & Eisenhardt, Inc., Philadelphia, Pa., died at his home November 15. He was also secretary of the Lovekin Pipe Expanding & Flanging Machine Co., and treasurer of the Charles Este Co. Mr. Wint's death will cause no interruption of the activities of Dienelt & Eisenhardt, Inc.

Richard T. Crane, president of the Crane Co., Chicago, died January 8, aged eighty years. Although a very successful manufacturer who, in common with the manufacturing world in general, had profited largely from the results of technical research, he was violently opposed to college education, and achieved national prominence through his publications and speeches against colleges and universities devoted to higher education. He was a supporter of manual training schools and contributed $200,000 annually for manual training instruction in Chicago.

Franklin Farrel, one of the best known business men of the Naugatuck Valley, died at his home in Ansonia, Conn., January 10, aged eighty-three years. He began at the age of fourteen to learn the mill trade with his father. In 1849 he became interested in the foundry business as a member of the firm of Farrel & Johnson. Later this firm was reorganized under the name of Farrel Foundry & Machine Co., with Almond Farrel, president. Franklin Farrel succeeded his father in the presidency, which position he held until his death. The Waterbury-Farrel Foundry & Machine Co., and the Ansonia Machine & Tool Co., were the same until March, 1880, at which time the late E. C. Lewis purchased the Waterbury plant from Mr. Farrel. Mr. Farrel was interested in all the commercial enterprises of his home town and died worth several million dollars.

William Donaldson, superintendent and secretary of the Champion Tool Works Co., Cincinnati, died January 15 of Bright's disease at his home in Ludlow, Ky. He was born in Cincinnati, 1842, and commenced his trade as a machinist at the early age of twelve, which business he has followed during his lifetime, except to serve throughout the Civil War as a quarter gunner on the gun boat *Chillicothe* plying on the Mississippi River. In the early 70's he was, for a number of years, in business in Cincinnati as a manufacturer of screw cutting engine lathes. His later work after disposing of his lathe business was as superintendent and designer of machine tools for a number of the most prominent shops in Cincinnati, having been connected at different times in these capacities with Lodge & Davis, American Tool Works Co., Fosdick Machine Tool Co., Bradford Machine Tool Co., Dreses Machine Tool Co., and Greaves, Klusman & Co., all of Cincinnati. For the six years prior to his death he was superintendent and secretary of the Champion Tool Works Co. Mr. Donaldson was a man of very wide experience in the design and manufacture of the various types of machine tools, and was frequently consulted as a patent expert and in other advisory capacities on the design and construction of intricate machinery for various purposes.

Franklin E. Snow, for thirty-two years connected with Wells Bros. Co. of Greenfield, Mass.—for many years as vice-president and general manager—died in Boston on January 6. To Mr. Snow's untiring energy and remarkable business ability is due, in a great measure, the success of the Wells Bros. Co.; for the business and selling end was entirely in his charge for many years, and under his direction increased from a small beginning until the concern became one of the largest in its line in the country. With all his shrewdness and

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care for the interests of his concern Mr. Snow impressed every one who met him in a business way with his genial and wholesouled personality. Although he worked unceasingly to build up the business, he found time to devote to many local undertakings of a business, social and philanthropic character, and in his death Greenfield has sustained a loss which can hardly be repaired. Mr. Snow was born in Griswoldville in 1849. He received a common school education, and in 1867 became bookkeeper for the Shelburne Falls National Bank, which position he left to engage in the banking business in Halifax, Nova Scotia, afterwards going to Wisconsin, where he established a general store. Then he entered a bank in Chicago and afterwards became cashier of the First National Bank, Negaunee, Mich., later returning to Chicago as the teller of the Northwestern National Bank. In 1880 Mr. Snow returned to Greenfield and became associated with the firm of Wells Bros., which was afterwards incorporated as the Wells Bros. Co. At the time of his death he was president of the Greenfield Machine Co., a director of the First National Bank, and a trustee of the Franklin Savings Institution, besides giving his time in various capacities connected with charitable and other institutions. Mr. Snow was a 32nd degree Mason, and for many years had been prominent in the order. He left a widow and three daughters.

* * *

It is necessary for the well-being of man that he should be dissatisfied. He must want something he has not got, and want it badly enough to be willing to exert himself to the full extent of his powers to get it. That is the way that humanity makes progress.

* * *

COMING EVENTS

February 5-10.—Commercial vehicle exhibition, Coliseum and First Regiment Armory, Chicago, Ill.

April 3-14.—International Aviation and Aero Exhibition, at Berlin, Germany. For further information address Verein deutscher Motorfahrzeug-Industrieller, Potsdamer str. 121, Berlin, W. 35.

May 13-15.—Triple convention of the American Supply and Machinery Manufacturers' Association; National Supply and Machinery Dealers' Association; and Southern Supply and Machinery Dealers' Association, at Norfolk, Va., Monticello Hotel, headquarters. F. D. Mitchell, secretary-treasurer, 309 Broadway, New York.

May 14-17.—Sixth annual convention of the Master Boiler Makers' Association at the Fort Pitt Hotel, Pittsburg, Pa. J. R. Flannery, of the Flannery Bolt Co., Frick Bldg., Pittsburg, Pa., secretary and treasurer of the general committee of arrangements.

June 12-14.—Annual convention of the American Railway Master Mechanics' Association at Atlantic City, N. J.

June 17-19.—Annual convention of the Master Car Builders' Association at Atlantic City, N. J.

August 20.—Annual convention of the International Railroad Master Blacksmiths' Association at Hotel Sherman, Chicago, Ill. J. E. Carrigan, Rutland Railway, Rutland, Vt., chairman of the executive committee.

September 2-7.—Sixth congress of the International Association for Testing Materials at the Engineering Societies Building, 29 W. 39th St., New York. One of the important functions of this association is to establish standard specifications for materials used in manufacture and construction. The cooperation of engineers and others who are engaged in the purchase and use of the raw materials of the trades is requested. The annual dues are $2, with no initiation fee. Mr. H. F. J. Porter, secretary, 1 Madison Ave., New York.

October 4-26.—Engineering and Machinery Exhibition, Olympia, London, England. The exhibition will be especially of machine tools.

SOCIETIES AND COLLEGES

AMERICAN SOCIETY OF ENGINEER DRAFTSMEN, headquarters, 116 Nassau St., New York, has been granted a charter for its St. Louis, Mo., section. Mr. L. T. Maenner, chief draftsman of the Missouri Pacific Railway, is the first chairman.

SCHOOL OF MINES AND METALLURGY, UNIVERSITY OF MISSOURI, Rolla, Mo. Bulletin No. 1 on friction in air pipes, giving the results of a series of tests on small pipes to determine the value of a constant. While the results are indeterminate for ¾ and ½ inch pipes, the value of the tests will no doubt be appreciated by engineers interested in the subject.

AMERICAN MUSEUM OF SAFETY, 29 W. 39th St., New York. Leaflet illustrating improved methods of emergency treatments for wounds. This leaflet is one of a series issued for the instruction of men in shops, mills and factories. The series issued No. 1 Alcoholism in Industrial Safety; Leaflet No. 1 Presses and Punches; Industrial Hygiene; Leaflet No. 1, Safety for the Molder.

AMERICAN MUSEUM OF SAFETY, 29 West 39th St., New York. "Manual of Safety—Yard Practice, Walks and Railings," by Charles Kirchhoff and Dr. Wm. H. Tolman. The manual illustrates various warning signs, crossing gates, stairways for crane operators, means for safely repairing electric overhead cranes, and numerous other improvements in the conditions of industrial works that reduce the hazard of life and limb.

AMERICAN SOCIETY OF SWEDISH ENGINEERS, 271 Hick St., Brooklyn, N. Y., has arranged a program for two lectures a month during March, April and May. At the March 2 meeting Mr. A. L. Valentine, of the Pratt & Whitney Co., Hartford, Conn., will speak on "Comparison between Industrial Conditions in the United States and Europe"; on March 16, Mr. H. L. Gantt, consulting engineer, New York City, will speak on "Scientific Management"; and on April 20, Mr. Ralph E. Flanders, of the Fellows Gear Shaper Co., Springfield, Vt., will speak on "The Larger View of Scientific Management."

SOCIETY OF AUTOMOBILE ENGINEERS held its annual convention in New York beginning January 8 and concluding January 20. The membership has continued to increase during the past year. In June, 1910, the society had 310 members, in January, 1911, 614 and in January, 1912, 1200. The technical work carried on by the society is of great general value to the industry, comprising a wide range of subjects, all having directly to do with the design and construction of automobiles and auto-trucks. The following technical papers were contributed: "Motor and Transmission for Commercial Cars," by Eugene P. Batzell; "Silent Chains," by Chester S. Ricker; "Second Report of the Sheet Metals Division of the Standards Committee"; "Starters for Gas Engines," by J. W. Fitzgerald; "Second Report of Springs Division of the Standards Committee"; "Proportional Elastic Limit and Elastic Limit," by Henry Hess; "Efficiency of Compound Gas Engines," by Eugene P. Batzell; "Automatic Spark Control," by Lon R. Smith; "Balance of Automobile Motors," by Ernest R. Fried; "Increasing the Utility of Commercial Cars by Auxiliary Loading and Unloading Devices," by Edward W. Curtis, Jr.; "Wire vs. Wood Wheels," by Bert Morley; "The Importance of the Consideration of the Magneto in Relation to Engine Design," by F. E. Moskovics; "Worm and Gear as the Ultimate Drive Applied to Heavy Power Vehicles," by Ralph H. Rosenberg; "Comments on Metal Gages," by T. V. Buckwalter; "Details and Peculiarities of Design of Foreign Cars," by Wm. Guy Wall; "Wood Artillery Automobile Wheels," by C. B. Hayes.

NATIONAL METAL TRADES ASSOCIATION has appointed a safety inspector in accordance with the spirit of the following resolution which was adopted by the association's committee on systematic compensation for industrial accidents: Whereas, the question of systematic compensation for industrial accidents is receiving wide attention in this country; and whereas, the matter of the prevention of such accidents is of the first importance and demands the greatest consideration by all employers: be it resolved that this convention of the National Metal Trades Association recommends to its administrative council the consideration of a plan for the inspection of the shops of its members, which plan will furnish to the members themselves an opportunity of judging the comparative state of their own equipment and system for the preservation of human life, and will show to the association what progress, if any, may be made from time to time in the furnishing of adequate safety devices; and be it further resolved that the administrative council be authorized to appropriate the funds to a reasonable amount to make such inspection, if upon their investigation the plan appears feasible. Robert Wuest, commissioner, New England Bldg., Cleveland, Ohio.

FRANKLIN INSTITUTE ALUMNI ASSOCIATION, organized by graduates of the School of Mechanic Arts of the Franklin Institute, is desirous of obtaining the addresses of all graduates and former students in this country and elsewhere. The school was established in 1824, and has been conducted continuously since that time, graduating each year a number of students, some of whom have taken an important part in the industrial activities of the country. The records on file at the institute are incomplete, in that they do not contain the present addresses of many former students, and it is therefore impossible to reach a great number of them. The association was formed for the purpose of promoting closer relations among the graduates, and by cooperation to further, if possible, the professional interests of each member. The officers recently elected are anxious to get into communication with the many graduates of the school who are scattered throughout the country with a view of presenting to them the objects of the association and the advantages of membership. Former graduates or those who may have any information relating to them are requested to communicate with the secretary of the association, Mr. Charles E. Hubsch, who can be addressed care of the Franklin Institute, Philadelphia.

NEW BOOKS AND PAMPHLETS

THE ESSENTIALS OF SOIL FERTILITY. By Alva Agee. 61 pages, 3½ by 5¼ inches. Published by the Pennsylvania Railroad Co., Philadelphia, Pa.

FERTILITY AND FERTILIZER HINTS. By James Edward Halligan. 155 pages, 6 by 9 inches. Published by the Chemical Publishing Co., Easton, Pa. Price, $1.25.

TESTS OF A SUCTION GAS PRODUCER. By C. M. Garland and A. P. Kratz. 91 pages, 6 by 9 inches. 33 illustrations. Published by the University of Illinois, Urbana, Ill.

A BRIEF LABORATORY GUIDE FOR QUALITATIVE ANALYSIS. By Arthur E. Hill. 80 pages, 5 by 7 inches. Published by the Chemical Publishing Co., Easton, Pa. Price, $1.00.

PUBLICATIONS OF THE BUREAU OF STANDARDS, containing a list of all the publications issued by this Bureau. 43 pages, 7 by 10 inches. Published by the Department of Commerce and Labor, Washington, D. C.

PROCEEDINGS OF THE NINETEENTH ANNUAL CONVENTION OF THE INTERNATIONAL RAILROAD MASTER BLACKSMITHS' ASSOCIATION. 251 pages, 6 by 9 inches. Published by the Association, A. L. Woodworth, secretary, Lima, O.

REPORT OF THE APPRENTICESHIP COMMITTEE TO THE ANNUAL CONVENTION OF THE NATIONAL METAL TRADES ASSOCIATION. 16 pages, 6 by 9 inches. Published by the National Metal Trades Association, Robert Wuest, commissioner, 605 New England Building, Cleveland, O.

DICTIONARY OF ENGLISH AND SPANISH TECHNICAL AND COMMERCIAL TERMS. By William Jackson. 164 pages, 4 by 6¾ inches. Published by Spon & Chamberlain, New York. Price $1.00.

In this work the compiler has endeavored to present a comprehensive list of the expressions used in the iron, steel, hardware and machinery business, for the use of those who are engaged either in a commercial or engineering capacity in the trade with the Spanish-speaking countries of Central and South America.

PORTLAND CEMENT. By Richard K. Meade. 512 pages, 6 by 9 inches. 169 illustrations, 53 tables. Published by the Chemical Publishing Co., Easton, Pa. Price, $4.50.

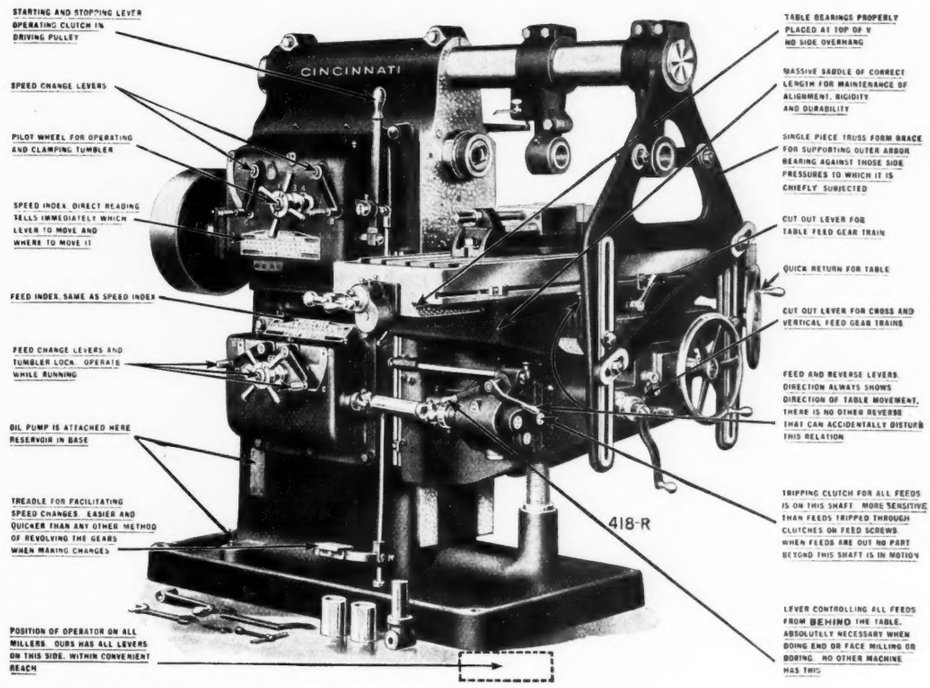
This treatise is the second edition of a work on Portland cement prepared to meet the requirements of both the chemist and engineer. The new edition has been entirely revised and much new matter has been added, particularly on the manufacture of cement. Descriptions of new appliances are included so that the work represents fairly well the present state of the industry in this country.

OFFICIAL REPORT OF THE TENTH ANNUAL CONVENTION OF THE NATIONAL MACHINE TOOL BUILDERS' ASSOCIATION. 154 pages, 6 by 9 inches. Published by the Association, Charles E. Hildreth, Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass., secretary.

This report contains the proceedings and the papers read before the association at its convention in New York City, October 10-11, 1911. Besides the president's, secretary's and treasurer's reports, the following papers are included: Task Work—the Basis of Proper Management, by H. L. Gantt; Shop Hygiene as a Factor in Efficiency, by Winthrop Talbot; Standardization of Machine Tools for the Benefit of the User, by L. P. Alford. The reports of the various committees of the association, presented to the meeting, are also included.

A SHORT COURSE IN GRAPHIC STATICS. William Ledyard Cathcart and J. Irvin Chaffee. 183 pages, 5 by 7½ inches. 58 illustrations. Published by D. Van Nostrand Co., New York. Price $1.50.

The purpose of this book has been to provide students of mechanical engineering with a brief course in graphic statics. Owing to the necessary limitations as to space thus imposed, the treatment has been restricted mainly to such matter as seems especially necessary for the solution of the problems met with in practice by mechanical engineers. The discussion of principles, as given in this book, is largely a summary of similar portions of the authors' treatise, "The


STARTING AND STOPPING LEVER OPERATING CLUTCH IN DRIVING PULLEY
SPEED CHANGE LEVERS
PILOT WHEEL FOR OPERATING AND CLAMPING TUMBLER
SPEED INDEX. DIRECT READING TELLS IMMEDIATELY WHICH LEVER TO MOVE AND WHERE TO MOVE IT
FEED INDEX. SAME AS SPEED INDEX
FEED CHANGE LEVERS AND TUMBLER LOCK. OPERATE WHILE RUNNING
OIL PUMP IS ATTACHED HERE RESERVOIR IN BASE
TREADLE FOR FACILITATING SPEED CHANGES. EASIER AND QUICKER THAN ANY OTHER METHOD OF REVOLVING THE GEARS WHEN MAKING CHANGES
POSITION OF OPERATOR ON ALL MILLERS. OURS HAS ALL LEVERS ON THIS SIDE, WITHIN CONVENIENT REACH
CINCINNATI
418-R
TABLE BEARINGS PROPERLY PLACED AT TOP OF V NO SIDE OVERHANG
MASSIVE SADDLE OF CORRECT LENGTH FOR MAINTENANCE OF ALIGNMENT, RIGIDITY AND DURABILITY
SINGLE PIECE TRUSS FORM BRACE FOR SUPPORTING OUTER ARBOR BEARING AGAINST THOSE SIDE PRESSURES TO WHICH IT IS CHIEFLY SUBJECTED
CUT OUT LEVER FOR TABLE FEED GEAR TRAIN
QUICK RETURN FOR TABLE
CUT OUT LEVER FOR CROSS AND VERTICAL FEED GEAR TRAINS
FEED AND REVERSE LEVERS. DIRECTION ALWAYS SHOWS DIRECTION OF TABLE MOVEMENT. THERE IS NO OTHER REVERSE THAT CAN ACCIDENTALLY DISTURB THIS RELATION
TRIPPING CLUTCH FOR ALL FEEDS IS ON THIS SHAFT. MORE SENSITIVE THAN FEEDS TRIPPED THROUGH CLUTCHES ON FEED SCREWS. WHEN FEEDS ARE OUT NO PART BEYOND THIS SHAFT IS IN MOTION
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Elements of Graphic Statics." A number of problems are given at the end of the book which will be found useful whether the book is used as a text-book in an engineering school or by the individual student of this subject. The book contains six chapters as follows: Force and Equilibrium Polygons; Trusses—Stress Diagrams; Stationary Loads—Shears and Moments; Live Loads—Shears and Moments; Center of Gravity—Moment of Inertia; Friction.

WORKS MANAGEMENT. By William Duane Ennis. 194 pages, 6 by 9 inches. Numerous tables and diagrams. Published by the McGraw-Hill Book Co., New York. Price $2.00.

In the preface of this book the author, who is professor of mechanical engineering at the Polytechnic Institute of Brooklyn, states that the book is not (other than incidentally) a presentation of Taylor's system of scientific management, although the casual reader would have this impression from its title and the present trend of writers on subjects of this kind. The reason for not dealing specifically with the Taylor system is that, while the author highly admires Mr. Taylor, in his opinion the Taylor system of shop management deals largely with mechanical method rather than with management proper, and the Taylor plan of management is, therefore, not a universal plan; hence, it seemed to the author of this book that a presentation of some of the underlying principles of factory administration would be profitable, and he has endeavored to be specific as to some of the principles on which are based the methods of what seems to him good management. The book contains chapters on Management Units; Cost Elements and Classifications; Statistical Records; Labor; Material; Expense Burden; Depreciation; Industrial Organization; Principles of Accounting; and on The Industrial Plant—the Physical Basis of Industry. At the end of the book a number of problems, mostly numerical, have been incorporated, which are intended for use when the book is employed for class-room instruction, in order to emphasize the principles presented.

VALVES, VALVE GEARS AND VALVE DIAGRAMS. By Franklin DeR. Furman. 130 pages, 8 by 10 inches. 152 illustrations. Published by the author, Stevens Institute of Technology, Hoboken, N. J. Price, $3.75.

The material in this book, aside from the drafting-room problems, has been arranged for class-room work, but is based upon the methods in which the work in the design of valves and valve gears is carried out in actual practice. The author, in his capacity of professor of mechanics and machine design at Stevens Institute of Technology, has arranged the material in such a way as would best fit in with a general course of mechanical engineering at Stevens Institute. Some features that have been original in their conception, have been introduced. Principal among these features may be mentioned the introduction of numbers for marking the order of the drawing of lines in the construction of valve diagrams in the early exercises; the formula for determining exactly the steam lap by the Zeuner diagram; the combining of the valve ellipse with the steam engine indicator card; the method of determining the proper width of cut-off blocks for the Meyer valve; and the Corliss valve-gear design, etc. The book is divided into five sections of which the first deals with simple steam engines, the second with valve diagrams, the third with types of valves, the fourth with eccentrics and shaft governors, and the fifth with valve gears. Typographically, the width of the printed page, the lines being six inches long, is objectionable, as it makes the book difficult to read. If, on account of the illustrations, a large size page was deemed advisable, a double-column arrangement of the printed matter would have been preferable for the convenience of the reader.

FOUNDRY PRACTICE. By R. H. Palmer. 332 pages, 5¼ by 8¼ inches. 154 illustrations. Published by John Wiley & Sons, New York. Price $2.00.

This book is written by a man who has had not only the practical experience so necessary to write an authoritative work on foundry practice, but who has also for some time been instructor in foundry practice at the Worcester Polytechnic Institute, and thereby acquired the necessary experience in putting his knowledge in such forms as to be most easily comprehended by others, to whom he wishes to impart it. The book is intended as a reference and hand-book for molders, students and apprentices, and was written especially to meet the demand for a suitable text-book on this subject, the lack of which proved a handicap to the author while engaged as instructor at the Worcester Polytechnic Institute. The book begins with a description of the simplest type of mold and leads the student gradually through the more difficult kinds of work in green and dry sand and loam. The contents and scope of the book can be best understood from a review of the chapter heads which are as follows: The Mold—Its Form and the Methods of Making It; Irregularly Shaped Patterns; Floor Molding; Light Crane Floor Work; Bedding Patterns in the Foundry Floor; Molding Columns; Molding with Sweeps; Molding Car-wheels; Skin-dried Molds; Dry-sand Molds; Loam Molding; Molds for Steel Castings; Dry-sand Cores; Setting Cores and Using Chaplets; Gates and Gating; Risers, Shrinkheads and Feeding Heads; Treatment of Castings While Cooling; Cleaning Castings; Molding Machines; Mending Broken Castings; Molding Tools; Molding Sands; Iron and Its Composition; The Cupola and Its Operation; The Air Furnace and Its Operation; The Brass Foundry; Foundry Equipment.

THE WALSCHAERTS AND OTHER MODERN RADIAL VALVE GEARS FOR LOCOMOTIVES. By W. W. Wood. 245 pages, 5 by 7½ inches. 50 illustrations and 5 folding plates. Published by Norman W. Henley & Son, New York. Price $1.50.

This book, now in its third revised and enlarged edition, contains, in the first place, a practical treatise on the locomotive valve gear invented by Walschaerts. The book contains the same matter relating to this valve gear as the previous edition; but, as during the last few years the development of other styles of radial valve gears has been considerably stimulated by the adoption of the Walschaerts valve motion, practically to the exclusion of the old link motion on nearly every railroad in America, two of the most successful of the other types of radial valve gears have also been fully described in the present edition. Questions and answers explaining the proper method of procedure in cases of breakdowns of either style of gear, while on the road have been included. The author says in his preface that the question as to how the Walschaerts gear may be "set" is asked so often that it has been deemed advisable to fully answer it in this edition. The contents of the book are divided into five parts, of which the first contains an analysis of the Walschaerts valve gear; the second, a treatise on the designing and erecting of the valve gear; the third, a review of the advantages of this gear; and the fourth, a series of questions and answers relating to the Walschaerts valve gear. The fifth division deals with several subjects, such as the setting of valves with the Walschaerts gear, the Hobart-Allfree valve and valve gear, and the Baker-Pilliod valve gear in its original and improved form. A discussion of the three primary types of locomotive valve motions is also included in this division.

THE STEAM ENGINE AND TURBINE. By Robert C. H. Heck. 631 pages, 6 by 9 inches. 402 engravings. Published by D. Van Nostrand Co., New York. Price $5.00.

The author of this book, who is professor of mechanical engineering at Rutgers College, has intended it primarily as a text-book for engineering colleges, and throughout the preparation of the book its purpose as a guide in the class-room has been kept in mind. Hence the book deals more with the theory of the steam engine than with purely practical consideration, although some attention is also given to illustrating and describing conventional designs of engine details. The book is in no sense elementary, and it is assumed that the student approaches the subject with at least a general knowledge of the working of a steam plant and with a good preparation in the elements of physics and mechanics. An excess of algebraical mathematics has, however, been avoided, preference having been given to graphical methods. Many numerical examples have been included to illustrate the principles explained. A new steam table is presented, differing slightly from that of Marks and Davis, but founded on the same experimental data. While both engines and turbines are dealt with, the former receive much the larger share of the space, although the difference is less than may appear, since several of the chapters in the first part of the book apply to both. The scope and contents of the book will be best appreciated by a list of the chapter heads, which are as follows: A General View of the Subject; Elementary Theory of the Heat Engine; Properties and Behavior of Steam; Ideal Steam Cycles; Action of the Steam in the Engine; Performance and Efficiency of the Engine; Working and Construction of the Engine; Valve Gears and Governors; Action of the Steam in the Turbine; Design and Construction of the Turbine; and Sundry Steam Appliances.

THE GASOLINE AUTOMOBILE. VOL. I. THE GASOLINE MOTOR. By P. M. Heldt. 506 pages, 5½ by 8½ inches. 314 illustrations. Published by the Horseless Age Co., New York. Price $4.00.

The author of this book, who is editor of the *Horseless Age*, has in this treatise presented a comprehensive work of considerable value to the automobile trade. The matter contained was originally published serially in the *Horseless Age*. Although the automobile industry has developed during the last few years so that it now is one of the leading industries of the country, no books treating comprehensively on automobile design have been published. The books that so far have appeared on this subject have been limited in their scope, and do not fully fill the requirements of the designer and engineer. The author states in the preface that the need for a comprehensive work on the subject has often been strongly impressed upon him from the fact that he himself has frequently been asked to recommend a book of this nature, and being unable to do so, he resolved to make an attempt to supply this deficiency in automobile literature. It is proposed to cover the subject in two volumes. The first volume, here reviewed, deals with gasoline motors, and the second, not yet published, will treat of the running gear and the transmission. Ignition appliances, carbureters and radiators are not dealt with, because these accessories are rarely designed in the automobile factory. Mathematical treatment has been avoided where not entirely necessary. In cases where it has been necessary to give the mathematical analysis, the treatment has been made as clear as possible, and the application of formulas derived have been illustrated by practical examples in most instances. A special folder accompanying the book contains a considerable number of large plates showing sectional views of modern American and European motors of different types. The following list of chapter heads will give an idea of the contents of the book. The Working Media—Gasoline and Air; The Laws of Gases—Thermodynamics; The Otto Cycle; Conversion of Reciprocating Into Rotary Motion; Balancing of the Engines; The Cylinder; Piston, Piston Rings and Piston Pin; Offset Cylinders; The Crankshaft; The Connecting-rod; Valves and Valve Gears; Cam-shaft and Accessories Drives; Crank-case and Oiling System; Starting Crank, Manifolds and Muffler; The Flywheel; Speed Control—The Governor; Power Output and Other Characteristics; Sleeve; Piston and Rotary Valve Motors; Air Cooling; The Two-Stroke Cycle Motor; and Motor Tests.

CATALOGUES AND CIRCULARS

NAPPANEE IRON WORKS, Nappanee, Ind. Circular of the Victor combined punches and shears.

LOCOMOTIVE EQUIPMENT CO., Detroit, Mich. Catalogue No. J–1 of bearings for locomotives and cars.

PAGE-STORMS DROP FORGE CO., Chicopee, Mass. Leaflet illustrating the "Gem" all steel screw-driver.

WEBSTER MFG CO., Tiffin, Ohio. Circular illustrating and describing the Webster coal handling system.

AMERICAN BLOWER CO., Detroit, Mich. Bulletin No. 306 descriptive of the "Vento" cast-iron hot-blast heater.

ROBBINS CONVEYING BELT CO., Park Row, New York. Bulletin No. 47 illustrating installations of belt conveying apparatus.

STERLING ELECTRIC CO., 9 S. Fifth St., Minneapolis, Minn. Catalogue No. 12 of automobile ignition and lighting equipment, and aeronautic supplies.

SIMONDS MFG. CO., Fitchburg, Mass. "Simonds Guide for Millmen." No. 2. An imaginative trip through the company's new steel mill at Lockport, N. Y., graphically set forth.

INDUSTRIAL INSTRUMENT CO., Foxboro, Mass. Bulletin No. 58 illustrating and describing the "Industrial" dial type indicating thermometers, and the "Industrial" improved thermometers.

SPRAGUE ELECTRIC WORKS OF GENERAL ELECTRIC CO., 527 West 34th St., New York. Bulletin No. 239 describing full automatic push button control systems for the operation of newspaper presses.

BOSCH MAGNETO CO., 223 W. 46th St., New York. Circular of Bosch products including magnetos for motor cars, motorcycles, motor trucks, motor boats, stationary engines, the Bosch oiler and spark plugs.

H. W. JOHNS-MANVILLE CO., 100 William St., New York. Catalogue No. 112, J. M. sectional conduit for insulating pipes conveying steam, water, gas or liquids underground, giving plans of some of the most important installations.

HYATT ROLLER BEARING CO., Newark, N. J. Mailing card illustrating Hyatt flexible roller bearing wheels under a quarry truck which was buried beneath 15 tons of rock. The bearings withstood the shock without suffering material injury.

VANADIUM SALES CO., OF AMERICA, Frick Bldg., Pittsburg, Pa. *American Vanadium Facts*, a monthly publication describing, in the January number, the position of vital importance occupied by vanadium in modern automobile construction.

RICHARDSON-PHENIX CO., Hudson Terminal Bldg., New York. Circular illustrating the Richardson-Phenix lubricating system adapted to small power plants. All the various pipes, receivers, filters, pumps, etc., can be located on or close to the engine.

DOOLEY SMITH & CO., 133-137 Front St., New York, importers and exporters, are sending out a pamphlet of information regarding the resources of the island of Porto Rico, of interest to the manufacturers, capitalists and farmers of the United States.

J. FAESSLER MFG. CO., Moberly, Mo. Folder illustrating Faessler roller and sectional tube expanders, and flue cutting machines. The flue cutting machines are for cutting out the flues of locomotive boilers, and they have a record of 300 flues cut per hour.

BOURNE-FULLER CO., Cleveland, Ohio. Booklet entitled, "Tool Steel and Its Uses," containing complete catalogue of Scott's tool steels with tables of approximate weights, decimal equivalents, etc.; also practical suggestions regarding the treatment of tool steels.

BLAUGAS CO. OF AMERICA, 381 Fourth Ave., New York. Circular of Blaugas apparatus for isolated lighting plants and other situations requiring gas for illumination, heating, brazing, welding, or any other purpose to which ordinary illuminating gas is commonly put.

The first BORING, DRILLING AND MILLING MACHINE we ever made was named the

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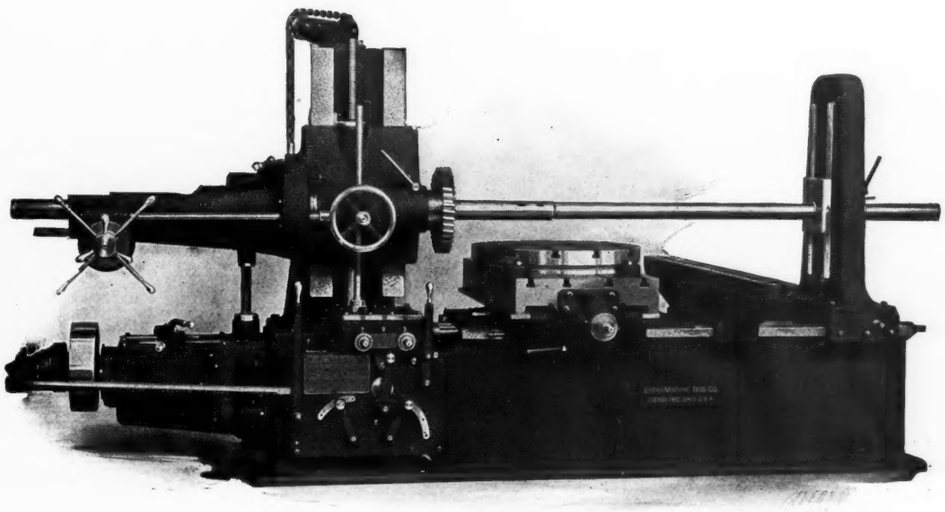

a commercial machine in the present state of the art. "ASK THE MAN WHO HAS ONE" if this is not true; or, better yet, ask the man who has several. We will be satisfied to abide by the decision of the USERS.

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AGENTS—C. W. Burton, Griffiths & Co., London. Alfred H. Schutte, Cologne, Berlin, Brussels, Paris, Milan, Barcelona, Bilbao. Donauwerk Ernst Krause & Co., Vienna, Budapest, Prague. Overall, McCray, Ltd., Sydney, Australia. Andrews & George, Yokohama, Japan. Williams & Wilson, Montreal, Canada.

University of Iowa FEB 1912

FOWDEN GASOLINE AND ELECTRIC ROCK DRILL CO., 1321-23 Real Estate Trust Bldg., Philadelphia, Pa. Catalogue of Fowden gasoline and electric rock drills, illustrating and describing a rock drill that can be operated by an electric motor, gasoline engine, or other motors.

ELECTRO-DYNAMIC CO., Bayonne, N. J. Data sheets, Nos. 1 and 2, giving wiring diagrams for shunt-wound adjustable, interpole motor with Cutler-Hammer Bulletin No. 24 on 25 controller, clockwise rotation facing commutator end, and counter-clockwise rotation, facing commutator end.

HARVEY HUBBELL, INC., Bridgeport, Conn. Catalogue No. 14 of "Hubbell" electrical specialties comprising lamp sockets reflectors, shade holders, lamp guards, pull switches, adapters, socket bushings, candelabra sockets, outlet box adapters, and other interior electric lighting equipment.

BUFFALO FORGE CO., Buffalo, N. Y. Catalogue No. 199 on "Buffalo" conoidal blowers and exhausters. These exhausters are so designed that the direction of the air current is gradually changed, thus avoiding large losses due to eddies and frictional resistance common to the usual type of exhauster.

NAPPANEE IRON WORKS, Nappanee, Ind. Catalogue "A" illustrating and describing a portable cylinder boring bar designed by J. W. Rosburgh. These bars are made for boring engine cylinders, etc., and are constructed in six sizes, the diameter of the boring bar ranging from 2 to 4½ inches inclusive.

GENERAL ELECTRIC CO., Schenectady, N. Y. Bulletins No. 4912, on General Electric ozonators; No. 4895, on electric fans; No. 4897, on G-E Edison "Mazda" lamps for standard train lighting service; No. 4902, on direct-current switchboards; and No. 4908, on the lighting of hotels, cafes and clubs.

HAMILTON-BEACH MFG. CO., Racine, Wis. Circular of the Hamilton-Beach portable electric grinder for grinding dies, reamers, cutters, etc. The circular illustrates the use of the grinder on the milling machine, sharpening cutters in position; on the shaper, grinding dies; and on the lathes, grinding dies.

GRAND RAPIDS PUBLIC LIBRARY, Grand Rapids, Mich. Bulletin containing a section on vocational guidance with an outline of a course of study in the Central High School and a selected line of books for teachers and pupils. The bulletin will be found of general interest to those concerned in vocational education.

CLEVELAND HARDWARE CO., Cleveland, Ohio. Catalogue supplement of drop-forge geared blanks, comprising bevel pinions, spur pinions, bevel gears, spur gears, and sprockets of various style and sizes. The catalogue concludes with tables of useful data on the elements of bevel and spur gearing of value to the drafting-room and shop.

HYATT ROLLER BEARING CO., Newark, N. J., is sending out cards giving striking examples of the various uses of Hyatt flexible roller bearings. One of these shows a huge bottle sign, 20 feet in diameter, 50 feet high and weighing 17 tons on the top of a high tower, revolving at a speed of 107 feet per minute upon Hyatt flexible roller bearings.

CHICAGO PNEUMATIC TOOL CO., Fisher Bldg., Chicago, and 50 Church St., New York. Bulletins No. 34 A, Class "G" steam-driven compressors; No. 34 C, tandem gasoline-driven compressors; No. 34 E, railroad type duplex steam-driven compressors; No. 34 H, general instructions for installing and operating "Chicago" pneumatic compressors.

INGERSOLL-RAND CO., 11 Broadway, New York. Twelve-page 6 by 9 pamphlet of the "MC-22" telescope feed hammer drill. This drill is of the valveless type in which the piston itself performs the valve functions by covering or uncovering the ports which control its forward and back movement. This drill is intended for stoping, raising and to a limited extent, drifting.

SAFETY AIR-BRAKE HOSE-COUPLER CO., 21 N. Third St., Harrisburg, Pa. Circular illustrating and describing the advantages of a new safety air-brake hose-coupler which permits trainmen to couple and uncouple air-brake hose without going between the cars. The value of these simple and easily used tools in saving human lives and limbs, can hardly be over-estimated.

RELIANCE ELECTRIC & ENGINEERING CO., 1056 Ivanhoe Rd., Cleveland, Ohio. Bulletin No. 7010 on automatic starting control for motor-driven machinery. The bulletin is illustrated with views of motor-driven machine tools provided with automatic starting control which in connection with the descriptive matter will make the bulletin of general interest to machine tool builders, users and operators.

SCHUMACHER & BOYE, Cincinnati, Ohio. Circular of Schumacher & Boye double-back-geared engine lathe with variable-speed motor drive. The motor is mounted on the headstock, and the controller, which is on the back of the bed, is operated by a handle on the right-hand end of the carriage. The lathe is furnished with wires carried in flexible tube conduits, and all the electrical apparatus is fitted and wired ready for use.

HYDRAULIC SALES CO., 1777 Broadway, New York. Matter descriptive of the LaFrance-Manly hydraulic transmission auto-truck for commercial purposes. The hydraulic principle eliminates change gears, clutches, differential gears, service brake, jack shaft, clutch pedal, gear changing levers, etc., incident to the gear drive. The system gives speed variations from zero to the maximum by small increments.

HESS-BRIGHT MFG. CO., 2111 Fairmount Ave., Philadelphia, Pa. Numerical index to data sheets Nos. 1 A to 86, inclusive. These sheets give practical information upon ball bearings and their correct use, taking up a great number of the various ball-bearing mountings in more or less common use; also folder describing a special ball bearing grease and showing the effect of poor greases upon the surface of balls.

NATIONAL TUBE CO., Pittsburg, Pa. N. T. C. Bulletin No. 5 entitled "Steel Pipe vs. Wrought Iron Pipe in Refrigerating Work." The bulletin takes up the manufacture of wrought iron; manufacture of soft steel; properties of the different materials; pipe welding; corrosion resisting qualities; etc. Also N. T. C. bulletin No. 7 on the National Tube Co.'s regrinding valve. The construction of the valve is shown with line cuts and colored drawings, and data on lifts, sizes, disks, etc., are included.

CLEVELAND TWIST DRILL CO., Cleveland, Ohio. Folder No. 32 illustrating the "Paragon Flatwist" drills, and the "Paragon" sleeves, center collet and driving collet; also the Cleveland high-speed taper shank drills. The folder also reproduces the account of the remarkable tests made with Cleveland "Flatwist" drills at the American Railway Master Mechanics' and Master Car Builders' Associations' joint convention at Atlantic City, June 14-21, which was published in the August, 1911, number of MACHINERY.

SPRINGFIELD MFG. CO., Bridgeport, Conn. Catalogue of grinding machines and wheels. Wheels for all classes of service are listed, following which are the illustrations and descriptions of grinding machines, comprising the Springfield-Brandes vertical grinding planer; automatic planer surface grinders in four sizes; automatic oscillating planer surface grinders in four sizes; vertical and horizontal oscillating surface grinders; car-wheel grinders; automatic knife grinders; heavy paper and veneer knife grinders; face and variety grinders; guide bar and variety grinders; tool grinders; swing frame grinders; buffing lathes; roll grinders; special grinders; ring-wheel grinders; etc.

IDEAL CASE HARDENING COMPOUND CO., 1919 Broadway, New York. Treatise on casehardening, pack-hardening and annealing of steel with the "Ideal" casehardening compound. The compound is economical and non-poisonous, and is adapted for casehardening steel articles of every size and shape including battleship armor, armor vault plates, roller and ball bearings, gears, hubs, bushings, shafts, universal joints and a great multitude of machine parts that can be effectively treated by the casehardening process. The divisions of the book are: "Ideal Casehardening Compound"; "Points Worth Remembering"; "Casehardening Carbon Steels"; "Pack-Hardening"; "Annealing"; "Various Applications of Casehardening," etc. The book is sent free to any address.

GENERAL FIRE EXTINGUISHER CO., 1 Liberty St., New York. Bulletin on the "Grinnell" automatic sprinkler system for shops, mills, factories, offices, stores, institutions, and all large structures containing inflammable materials. The importance of the sprinkler system as the means for reducing fire hazard to a minimum, is becoming more and more generally appreciated as its efficiency is shown. The tremendous fire loss sustained in the United States alone every year is awakening business men generally to the need of providing apparatus that will automatically extinguish flames before they have gained headway. The bulletin illustrates buildings in which the sprinkler system is installed, and contains many testimonials from concerns whose plants are thus protected.

BETTS MACHINE CO., Wilmington, Del. Catalogue No. 24 on vertical boring and turning mills. The catalogue deals with the 5-foot, 6-foot and 7-foot Betts boring mills with worm or spur drive; 5-foot, 6-foot and 7-foot boring mills, extra heavy, with spur drive; 90-inch boring mill, special design, spur drive; 8-foot mill, spur drive; 8-foot mill, extra heavy, double drive; 10-foot mill, spur drive, standard pattern A; 10-foot mill, spur drive, standard pattern B; 10-foot mill, extra heavy, spur drive; 10-foot mill, double drive; 12-foot mill, spur drive; 12-foot mill, extra heavy, spur drive; 12-foot mill, extra heavy, double drive; 14-foot mill, spur drive; 14-foot mill, extra heavy, spur drive; 16-foot, spur drive; 20-foot, spur drive; 20-foot, extra heavy, double drive; also 7—10-foot extension boring mill, spur drive; 10—16-foot extension mill, spur drive; 12—18-foot extension mill, spur drive; 14—20-foot extension mill, spur drive.

HEALD MACHINE CO., 20 New Bond St., Worcester, Mass. Catalogue of Heald grinding machines, 115 pages, 6 by 9 inches, 96 illustrations. This is a complete catalogue of internal grinding machines, giving detailed information of the design and construction. A valuable part of the catalogue is entitled "Suggestions in Grinding," which division occupies fourteen pages of directions and advice to the user of grinding machines, and contains sixteen clearly made line engravings to illustrate the text. The Heald cylinder grinding machine is also described in detail, and directions are given for its use. Another section of the catalogue is devoted to the Heald ring and surface grinding machine, and still another to the American drill grinding machine. In this latter section very thorough instructions are given on drill grinding. The catalogue also shows the works of the Heald Machine Co., with the new addition, covering, in all, a floor space of over 50,000 square feet.

TRADE NOTES

J. W. WRIGHT & CO., dealer in machine tools and accessories, is now located at 1221-1223 North Broadway, St. Louis, Mo.

HENRY & WRIGHT MFG. CO., Hartford, Conn., has purchased the Parker Motor Co.'s plant in Hartford with the view of using it for the manufacture of the Henry & Wright drilling machines.

A. J. SMART MFG. CO., Greenfield, Mass., has just moved into a new three-story brick building having floors 40 by 250 feet. The new building enlarges the company's floor space to four times the former capacity.

SUPERIOR MACHINE TOOL CO., Kokomo, Ind., manufacturer of upright drilling machines, has recently added improvements to its shop equipment. The company will erect another large wing to the shop early in the coming spring. Business conditions are reported to be good.

BAIRD MACHINE CO., formerly of Oakville, Conn., opened its new factory in Stratford, just over the Bridgeport city line, January 1, which will employ about 200 men at the start. The company manufactures automatic wire bending machines, and builds special machinery to order.

JOSEPH T. RYERSON & SON, Chicago, Ill., have removed their Minneapolis, Minn., district offices under Mr. Wm. H. Sherwin to larger and more commodious quarters at 501 Third St., South, Minneapolis. The larger quarters will give better facilities for the display and demonstration of the various lines of iron and steel, machine tools, metal-working machinery and specialties.

TAFT-PEIRCE MFG. CO., Woonsocket, R. I., has opened an office in Chicago at 1038 National Life Bldg., in charge of Mr. A. H. Mitchel. The Chicago office will enable the company to better serve its customers in the Middle West in connection with the manufacture of light high-grade machinery, the redesigning of machines for economical manufacture, and the designing and construction of special tools and machinery.

DAYTON PNEUMATIC TOOL CO., Dayton, Ohio, entertained its employes with a banquet and smoker on the evening of December 27. A general discussion followed the banquet, preceded by remarks by the officers, on the future business outlook and methods best adapted for turning out the company's product in the most efficient manner. It is the intention of the company to make the banquet and smoker an annual event.

JOSEPH T. RYERSON & SON, Chicago, Ill., have opened a district office under Messrs. R. J. Stayman and J. H. Marlotte at 828 Ford Bldg., Detroit, Mich. Mr. Marlotte will act as special representative for machine tools, fabricating equipment, railroad shop machinery, high-speed drills and other tools. The office will facilitate the Ryerson service in the Detroit district on the standard lines of bar, plate, and structural products, and the complete line of rolled steel products.

AMERICAN ENGINEERING CO., Philadelphia, Pa., is a consolidation of Williamson Bros. Co., of Philadelphia, and the American Ship Windlass Co., of Providence, R. I. The first steps in this consolidation were taken in 1906 when the Williamson Bros. Co. purchased control of the American Ship Windlass Co., with the intention of gradually combining the two concerns into the line of marine production. The American Ship Windlass Co. was founded about fifty-three years ago, and Williamson Bros. Co. about forty-five years ago.

WATSON-STILLMAN CO., 192 Fulton St., New York, manufacturer of hydraulic machines with plant at Aldine, N. J., has been reorganized. The increasing use of hydraulic presses and the steady growth of the business necessitated an immediate extension of the company' facilities. To take care of the increasing scope it was considered advisable to reorganize the board of directors. The new officers elected are: Francis H. Stillman, president (re-elected); F. A. Stillman, vice-president; J. P. Bird, treasurer; A. F. Stillman, secretary and works manager; and Carl Wigtel, chief engineer.

H. W. JOHNS-MANVILLE CO., 100 William St., New York, has changed the location of its offices in Louisville, Ky., removing them from the Lincoln Bank Bldg., to 205 Paul Jones Bldg. The new and more spacious quarters are much better adapted to the company's requirements. The offices will be in charge of Mr. J. R. Chowning, who is well and favorably known throughout that section, having traveled through it from the Milwaukee office for considerable time. A com-

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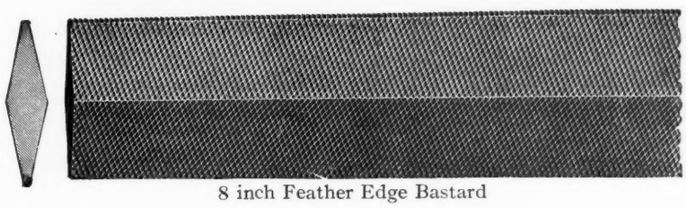

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plete line of asbestos and magnesia products, electrical supplies, packings, pipe coverings, roofings, etc., will be distributed from the Louisville office.

CROCKER-WHEELER CO., Ampere, N. J., has strengthened its organization by the addition of George W. Fowler, W. J. Warder, Jr., and A. K. Selden, Jr. Mr. Fowler and Mr. Warder have joined the company's sales department, while Mr. Selden enters its engineering department. Mr. Fowler was for many years the sales manager of the Garwood Electric Co.; Mr. Warder was formerly chief engineer and superintendent of Roth Bros., in Chicago, and later was connected with the Westinghouse Electric & Mfg. Co., at East Pittsburg; and Mr. Selden was for several years in charge of the design of the interpole adjustable speed motors manufactured by the Electro-Dynamic Co., Bayonne, N. J.

L. S. STARRETT CO., Athol, Mass., has increased its capital stock to $3,500,000, of which $1,500,000 is to be six per cent cumulative preferred stock and $2,000,000 common stock. The officers of the company are L. S. Starrett, president; F. A. Ball vice-president; F. E. Wing, treasurer and secretary; W. G. Nims, assistant treasurer; with a board of nine directors consisting of the officers named and M. B. Waterman, Augustus P. Loring, John A. McGregor, J. H. Drury, and W. B. McSkimmon. The last four are officers of the Union Twist Drill Co., of Athol. The Union Twist Drill Co. becomes a stockholder of the L. S. Starrett Co., and as such has representation on the board of directors, which is increased from five to nine. The L. S. Starrett Co. was incorporated in 1900, succeeding to the business established by L. S. Starrett in 1880 and conducted by him individually up to the time of its incorporation. The capital stock of the incorporation was $100,000 in 1900, since which time the business has increased far out of proportion to the original capital. L. S. Starrett continues in active control of the business.

MISCELLANEOUS

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